JPRS 78558

20 July 1981

USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 75

FBIS FOREIGN BROADCAST INFORMATION SERVICE

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semimonthly by the NTIS, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Indexes to this report (by keyword, author, personal names, title and series) are available through Bell & Howell, Old Mansfield Road, Wooster, Ohio, 44691.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

JPRS 78558

20 July 1981

USSR REPORT

MATERIALS SCIENCE AND METALLURGY

No. 75

CONTENTS

UDC 669.71'721'74:539.375:539.376

MECHANISMS OF SUPERPLASTIC DEFORMATION OF AMG6 ALUMINUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 51, No 3, Mar 81 pp 615-624 manuscript received 19 Oct 79

VALIYEV, R. Z., KAYBYSHEV, O. A., RABINOVICH, M. Kh., TIMOSHENKO, Yu. B. and CHISTOVA, O. L., Ufa Aviation Institute imeni S. Ordzhonikidze

[Abstract] The relationship and role of different mechanisms during superplastic deformation of AMg6 aluminum alloy were investigated. The microstructure, grain-boundary creep, intragrain dislocation slip and diffusional creep were studied. Grain-boundary creep has the greatest effect on the superplasticity of flow of the alloy. Diffusional creep makes the least contribution to superplastic deformation of the alloys. The combination of grain-boundary creep and intragrain dislocation slip increases superplastic properties and causes the appearance of diffusional creep during superplastic deformation. Grain-boundary creep, intragrain slip and diffusional creep all contribute to superplastic deformation of AMg6 aluminum alloy. Figures 5; references 21: 8 Russian, 13 Western.
[106-6521]

UDC: 669.725:538.653.2

INFLUENCE OF PLASTIC DEFORMATION ON MAGNETIC PROPERTIES OF POLYCRYSTALLINE BERYLLIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 51, No 2, Feb 81 pp 437-439 manuscript received 16 Apr 79, in final version 23 Jan 80

SAVIN, V. I., MARKIN, V. Ya., MOMIN, Ye. Yu. and DROZDOV, B. G.

[Abstract] A study is made of the influence of plastic deformation on the isotropicity of magnetic susceptibility of hot pressed polycrystalline beryllium. Cubic specimens 5 mm on a side were cut from hot pressed beryllium blanks so that the axis of the initial texture was perpendicular to one of the cube faces. Plastic deformation consisted of uniaxial compression at room temperature with the direction of the deforming force perpendicular to the direction of the axis of the texture. Magnetic susceptibility was measured by the Faraday method in a magnetic field of 12,000 oe with a gradient of about 1000 oe/cm. The variation of susceptibility of the beryllium with magnetic field intensity was slight. As the degree of plastic deformation increased the magnetic susceptibility anisotropy decreased, indicating a change in the degree of texturing of the beryllium, with the distribution of crystallographic axes becoming more uniform. X-ray analysis showed that at ε=10% the texture coefficient was indentical with all orientations of the cubic crystal, i.e., the characteristics of induced deformation equalled the initial texture. Figures 2; references 7: 4 Russian, 3 Western.
[92-6508]

UDC 669.28.056.9:621.793.14:620.184/187

STRUCTURE OF EXTREMELY HARD COATINGS BASED ON MOLYBDENUM PRODUCED BY CONDENSATION OF A VACUUM-ARC DISCHARGE PLASMA

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 81 pp 33-35

ANDREYEV, A. A., BULATOVA, L. V., BULATOV, A. S., KARTMAZOV, G. N., KOSTRITSA, T. V. and ROMANOV, A. A.

[Abstract] Silicon and molybdenum condensates and a ferrite series with complex spinel structure were produced by electric-arc sputtering in a vacuum. The condensate surface is bombarded continuously with intensive molybdenum ions having energy of more than 100 eV. The condensate is partially atomized, the temperature in the condensation zone is increased, the mobility of surface atoms is increased and the chemical reactions between the condensate and the components of the gaseous medium are activated. Evaporation devices using molybdenum alloy as the cathode and steel, copper and titanium plates as the substrate were employed to conduct the experiments. The derived nitride coating had significant broadening of the diffraction lines at both small and large angles of reflection. The lattice parameter and microdistortion increase continuously as the microhardness of the condensate increases in the single-phase zone. The high microhardness of molybdenum nitride coatings is enhanced by the presence of nitrogen in the nitride layers. The combination of titanium and zirconium with atmospheric components also contributes to an increase of microhardness of the condensate. Figures 2; references 13: 5 Russian, 8 Western.
[105-6521]

UDC 539.612:678.067

PHYSICO-CHEMICAL METHODS OF REDUCING INTERNAL STRESSES IN REINFORCED COATINGS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 81 pp 204-208
manuscript received 13 Feb 80

SUKHAREVA, L. A. and ZUBOV, P. I., Institute of Physical Chemistry,
USSR Academy of Sciences, Moscow

[Abstract] The effect of various physico-chemical factors such as the nature of film forming, the strength of interaction at the polymer-reinforcing system interface, the concentration and specifics of binder distribution in the boundary layer, chemical composition and structure of the fiber and the nature of its weave on internal stresses in reinforced systems was studied to develop ways of reducing these stresses. The adhesion of the film-forming filler to the surface has a significant effect on the internal stresses in reinforced coatings. Addition of various modifiers based on acrylic emulsion, paraffin emulsion and polyvinyl alcohol containing chromium and aluminum salts and volan N as reinforcing agents to polyester coatings more than doubled their adhesion strength. The weave of the fibers in the reinforcing material affects the internal stresses. The internal stresses in the system increase with introduction of reinforcing fillers that interact with the film-forming filler. Internal stresses were reduced by forming a homogeneous ordered structure in the polymer matrix by using structuring additives and fillers that provide regular alternation of active and inactive groups in the boundary layer. The use of compounds that do not interact chemically with the binder or of compounds that do not provide regular alternation of active and inactive centers at the polymer-fiber interface as fillers results in an increase of internal stresses and reduction of the adhesion of reinforced coatings. Adding optimum amounts of surfactants that reduce the strength of interaction at the polymer-fiber interface reduces internal stresses in reinforced systems. Modifiers of the elastic sublayer that contributes to acceleration of relaxation processes can also be used to reduce internal stresses. Figures 5; references 5: all Russian.
[108-6521]

UDC 541.135.3:546.77

ELECTRODEPOSITION OF MOLYBDENUM AND MOLYBDENUM-TUNGSTEN ALLOYS FROM TUNGSTENATE-MOLYBDENATE MELTS

Moscow ZASHCHITA METALLOV in Russian Vol 17, No 3, May-Jun 81 pp 371-374
manuscript received 27 May 80

TARASOVA, K. P., BARABOSHKIN, A. N., MARTEM'YANOVA, Z. S. and BYCHIN, V. P., Institute of Electrochemistry, Ural Science Center, USSR Academy of Sciences

[Abstract] A study was made of molybdenum and molybdenum-tungsten coatings produced by the process of electrodeposition from tungstenate-molybdenate melts. The electrolysis was performed in an Alundum crucible inside an Alundum test tube in air. Nickel plates on a current-carrying molybdenum conductor served as cathodes, a tungsten or molybdenum helix served as anode, and chemically pure tungstanate of an alkali metal (lithium, sodium, potassium) alloyed with tungsten anhydride served as the electrolyte. Chemically pure molybdenum trioxide was added in varying amounts. A stable continuous metal deposit was obtained at a cathode current density of 0.025 A/cm^2. Cathodic polarization curves were plotted, with a platinum foil semi-immersed in Na_2WO_4 + 10 mol% WO_3 serving as the reference electrode. Unlike in chloride melts, here molybdenum was found to be more electropositive than tungsten. In an experiment with melts containing 20 mol.% WO_3 at 850°C adding MoO_3 in low concentrations (below 1.5 mol.%) resulted in a deposition of molybdenum-tungsten alloys, adding MoO_3 in intermediate concentrations resulted in a deposition of metallic molybdenum, and adding MoO_3 in high concentrations resulted in a deposition of MoO_2 on the cathode, the critical MoO_3 concentration ranging from 1 mol.% in Li_2WO_4 to 5 mol.% in K_2WO_4. Here the electrodeposition process is described and the experimental results are interpreted by electrochemical reactions involving MoO_4^{2-}, $Mo_2O_7^{2-}$, WO_4^{2-}, $W_2O_7^{2-}$ ions, the nature of the deposit depending on the value of the equilibrium constant. Figures 3; references 5: all Russian.
[121-2415]

UDC: 621.793:553.9:669.295

INTERACTION OF PLASMA COATINGS WITH SUBSTRATES OF TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 81 pp 26-27

CHEVELA, O. B., candidate of technical sciences, and CHERDAKLI, A. G., engineer

[Abstract] A study was made of the structure and nature of interaction of plasma coatings of nichrome and tungsten with a substrate of OT4 titanium alloy. When exposed to air the surface material oxidizes, reducing the physical and mechanical properties of the coatings. The quantity of oxides depends on the chemical activity of the metal of the coating. As they impact against the substrate surface the sprayed particles are deformed and rapidly cooled, leading to residual

and shrinkage stresses which greatly influence the properties of the coating. The presence of undeformed particles in the layer indicates insufficiently uniform heating in the plasma jet, since the pressure in the jet is sufficient to deform particles which are adequately heated. Chromium oxides form in nichrome coatings at the boundary of flakes, creating a protective film on the metal and giving the chrome the valuable property of heat resistance. In contrast to plasma coatings of molybdenum and tungsten, nichrome coatings have a typically "vortexed" flake shape, with shorter flakes. The oxides of chromium fill the boundaries between flakes. The oxides of chromium are well bonded to the flakes. Spraying of tungsten, in contrast, forms volatile oxides which facilitate the formation of pores and cracks along the flake boundaries. The spraying distance influences the quantity of tungsten in fused areas. Figures 4; references 4: all Russian. [79-6508]

UDC 669.536.067

PRECIPITATION OF COBALT INTO THE FIRST CADMIUM SPONGE BY CEMENTATION WITH ZINC DUST

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 2, Mar-Apr 81 pp 45-48 manuscript received 20 May 80

BAGAYEV, A. S., North-Caucasian Institute of Mining and Metallurgy, Chair of Heavy Nonferrous Metals

[Abstract] In some zinc production plants a cadmium sponge is precipitated twice, the lean first sponge being used for production of zinc and the second sponge being used for production of zinc sulfate. Cobalt is then usually extracted from the zinc production process by means of a copper cake, the first cadmium sponge, or a xanthogenate cake. The first cadmium sponge is most expedient, and here the simultaneous precipitation of cobalt and cadmium into it is analyzed on the basis of tests made in a complete factorial experiment with industrial cadmium solutions and zinc dust: a) Cd = 7.5±2.5 kg/m^3, Co = 0.15±0.08 kg/m^3, Sb = 0.06±0.03 kg/m^3, b) M_{Zn} = 1.5±0.5 kg per kg of Cd, c) temperature t = 70±20°C, and Co^{+} = 1 kg/m^3 constant. A computer-aided evaluation of the results in terms of cobalt extraction efficiency indicates that there is an optimum temperature, dependent on the cadmium concentration, while cadmium extraction will be 98% efficient at 90°C with conventional doses of zinc dust. Recommended for cobalt precipitation are t = 75-85°C for 1.5-1 hrs., respectively, Cu = 1.5-2.5 g/liter, M_{Zn} = 1.6-2, and no additional Sb. References 2: both Russian.
[123-2415]

UDC: 621.763

MECHANISM OF STRUCTURE FORMATION IN TITANIUM-CHROMIUM CARBIDE COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 81 pp 10-16
manuscript received after rev.sion 1 Nov 81

KLIMENKO, V. N., PETROVA, A. M. and RADOMYSEL'SKIY, I. D., Institute of Problems of Material Science, Ukrainian Academy of Sciences

[Abstract] A study is presented of the mechanism of phase transformations occurring in a titanium-chromium carbide composite, and the composition of phases formed upon dissolution of chromium carbide particles in titanium is refined. The studies were performed on extruded and annealed specimens with up to 20 mass % chromium carbide, porosity 2-3%. Specimens annealed at 1150°C contained undissolved inclusions of the initial chromium carbide. Photomicrographs are presented which record the moment of fracture of the envelope surrounding the particles, forming a chain of inclusions of new phase, still retaining the outline of the envelope. X-ray and metallographic studies of the dissolved carbide particles determined that although its center is still chromium carbide, the envelope of titanium carbide formed around it is decomposed, meaning that upon dissolution of the chromium carbide inclusions a cyclical process of formation and dissolution of titanium carbide and chromium occrrs. Dissolution of the chromium carbide involves a decrease in the dimensions of the initial carbide particles. The mechanism of structure formation is therefore as follows: the process of dissolution of chromium carbide inclusions begins with diffusion of carbon and chromium into the titanium. As the inclusions of chromium carbide dissolve the carbon diffuses first, followed by chromium, into the titanium. Diffusion of carbon into the titanium is accompanied by the formation of titanium carbide as an envelope around the initial chromium carbide. The breakdown of the envelope of the new phase is accompanied by redistribution of the carbon in the titanium. A titanium-carbon solid solution is formed. A titanium carbide phase is liberated from the supersaturated solid solution. The dissolution of the chromium in the titanium occurs after breakdown of the envelope of titanium carbide, with the formation of a number of intermediate phases. Figures 5; references 8: 7 Russian, 1 Western.
[96-6508]

UDC: 539.43:621.791

LOW CYCLE FATIGUE OF COMPOSITE METAL MATERIALS WITH SOFT INTERLAYERS

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 81 pp 70-75
manuscript received 2 Jan 80

BOYKOV, L. V., GUR'YEV, A. V., STOLYARCHUK, A. S. and KHESIN, Yu. D.,
Volgograd Polytechnical Institute, Volgograd

[Abstract] A study is made of low cycle fatigue of metal composites with a soft transverse interlayer and the mechanism of development of plastic deformation is discussed, including plastic deformations at the division boundary between the soft and hard materials; a calculation equation is suggested for estimation of the endurance limit for low cycle loading. Titanium-aluminum alloys were tested with varying aluminum contents. The base material was an alloy with 6% Al, while the softer intermediate material consisted of titanium alloys with lower contents of aluminum (4, 2 and 0%) which have lower tensile strength. Accumulation of macroplastic deformation was determined by changes in diameter along the length of the specimen. The strength properties were tested by measuring microhardness along the axis of the specimen with an indentor. The influence of the thickness of the soft interlayer on low cycle fatigue strength of the composite materials was studied. Specifics of the development of macroplastic deformations under cyclical loadings were noted. It was found that the boundary layer of hard metal was invloved in plastic deformation as well as the soft interlayer, even though under the same conditions without the interlayer the deformation of the same hard metal would be elastic. Figures 6; references 12: all Russian.
[101-6508]

UDC: 539.67:669.71'781

DAMPING PROPERTIES OF AN ALUMINUM-BORON COMPOSITE MATERIAL

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 81
pp 155-157 manuscript received 21 Apr 79

POSTNIKOV, V. S., AMMER, S. A., KACHEVSKIY, A. N. and LAVRENT'YEV, V. I.,
Voronezh

[Abstract] A study was made of internal friction and the damping properties of an Al-B composite material. The measurements were performed with a torsional pendulum at 20 to 600°C at a frequency of about 1 Hz. The specimens measured 1 x 1 x 100 mm and were cut by the electric spark method from a composite specimen manufactured by diffusion sintering under pressure using a packet consisting of alternating layers of aluminum foil and B fibers laid out in parallel. The material was found to have good damping properties, resulting in the 20 to 400°C area primarily from superposition of the relaxation processes in the matrix and fibers, and above 400°C - from the contribution of Q^{-1}_b. Equations are presented

which can be used to predict the damping capability of any composite material based on the relaxation properties of the components and their volumetric content. Figures 2; references 6: all Russian.
[97-6508]

UDC 539.4:678:067:621.642

EVALUATING THE STRESS-STRAIN AND LIMITING STATES OF COMBINATION TANKS UNDER INTERNAL PRESSURE

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 81 pp 262-266
manuscript received 9 Apr 80

ZAYTSEV, G. P., VASILEVSKIY, V. M., GOLLANDTSEV, A. V. and KOPYL, N. I., Moscow Aviation Engineering Institute imeni K. I. Tsiolkovskiy

[Abstract] The stress-strain and limiting states of combination tanks were investigated by calculation and experiment. Two designs of combination tanks were studied: first a metal shell of equal thickness in the cylindrical and hemispherical parts with wall thickness of 2.4 mm and with the cylindrical shell strengthened in the annular direction by 15 layers of would unidirectional fiberglass ribbon, and the second a metal shell with a wall thickness of 4.8 mm in the cylindrical part and one with a wall thickness of 2.4 mm in the hemispherical parts. A series of equations was derived to calculate the stress-strain state in the elastic part of the shells. The internal pressure at which glass fiber-reinforced plastics used in the shells begins to lose integrity is 5 to 10 percent lower than the internal pressure that produces plastic deformations in the metallic layer. The tanks break down sequentially with the metallic layer breaking down first, followed by the glass fiber-reinforced plastic shell. All tanks subjected to hydraulic pressure broke down without the formation of fragments. Figures 5; references 5: all Russian.
[108-6521]

UDC 624.074.4:678

DEFORMATION AND BREAKDOWN OF CYLINDRICAL GLASS FIBER-REINFORCED EPOXIDES UNDER INTERNAL PULSED STRESS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 81 pp 249-255
manuscript received 4 Mar 80

TSYPKIN, V. I., RUSAK, V. N., SHITOV, A. T. and IVANOV, A. G., Moscow

[Abstract] The deformation, breakdown and sensitivity of free cylindrical glass fiber-reinforced epoxide shells to defects under internal pulsed stress were investigated and their strength was compared to the strength of steel shells under similar conditions. The glass fiber-reinforced epoxide shells had identical

dimensions and were produced by winding glass fiber 0.2 mm thick that had been previously impregnated with an epoxide resin binder. The steel shells were subjected to one-time and multiple loading. The glass fiber-reinforced epoxy shells showed high specific strength and low sensitivity to cracks when exposed to pulsed loading compared to steel shells. Compared to steel shells, glass fiber-reinforced epoxy shells showed only local breakdown. Their low sensitivity to defects is determined by the fiberglass fabric. The ultimate dynamic compressive strain contributes to the strength of glass fiber-reinforced epoxy shells under one-time pulsed loading. Figures 7; references 10: all Russian.
[108-6521]

UDC 624.073:539.4:678.067

NATURAL OSCILLATIONS OF TRAPEZOIDAL FLAT AND SPHERICAL THREE-PLY PANELS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 2, Mar-Apr 81 pp 238-243
manuscript received 25 Mar 80

SHALASHILIN, V. I., KOLESNIKOV, I. Yu., LOZHKIN, O. B. and KHAGAYEV, V. A.,
Moscow Aviation Institute imeni S. Ordzhonikidze

[Abstract] The natural oscillations of three-ply trapezoidal flat and spherical panels with honeycomb filler, freely supported along the edge, were investigated. The theory of sloping three-ply shells with transversal-isotropic filler was used to construct the theoretical solution. The continual filler parameters were determined from theoretical solution by the parameters of the specific honeycomb filler. The experimental results for rectangular fiberglass panels with honeycomb filler are compared to the theoretical results. The effect of the main parameters of three-ply honeycomb panels on fundamental frequency was also investigated. The membrane analogy was used to determine the natural frequencies for polygonal flat and spherical three-ply panels that were freely supported. The natural oscillations of a trapezoidal membrane were solved in quadratic approximation by the perturbation method and by the method of straight lines. The theoretical and experimental frequencies for a rectangular plate were compared to determine the validity of the mathematical model of a three-ply honeycomb panel. Figures 5; references 11: all Russian.
[108-6521]

IMPROVING CORROSION RESISTANCE WITH THINNER ELECTROPLATING

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 22 May 81 p 2

[Article by Doctor of Technical Sciences Professor A. Ginberg, Moscow: "Microns Which Save Millions"]

[Text] It has been calculated that one out of every five of the world's blast furnaces is producing... in compensation for corrosion. But even the cost of these many millions of tons of metal does not reflect the true picture of losses. Machinery, equipment, and transport vehicles sometimes break down due to parts corrosion. And these losses would be even greater if science had not armed industry with means of combating corrosion.

One of the most effective of these means is the technique of coating steel products with a thin film of nonferrous metals. This task is today being performed by more than 4000 electroplating shops operating in our industry. But the need for protection against corrosion is so great that by the year 2000, according to the predictions of experts, electroplating production capacity will increase to four times the present level.

The reverse side of this rapid advance is well known: already today electroplating operations are consuming immense quantities of short-supply and costly nonferrous metals. And the cost of the protective coatings frequently is equal to that of the steel products themselves. But if the products themselves, having suffered corrosion, are scrapped for remelting, and a large percentage of ferrous metals are recycled, the costly coatings as a rule are irrevocably lost.

And yet the worldwide shortage of nonferrous metals is steadily worsening. This includes metals used for protective coatings. Therefore we must already today commence searching for ways to economize in these metals, without waiting for the volume of electroplating production to increase sharply. Particularly since considerable scientific research has already been conducted in this problem area.

First of all, savings in nonferrous metals can be achieved by decreasing the thickness of coatings. At the present time copper, nickel, zinc, chrome, cadmium and tin protective films average about 12-30 microns in thickness. A negligible amount, one would think. But not for electroplating technology. These microns represent hundreds of thousands of tons of nonferrous metals. And the most vexing thing is that a substantial portion is being expended... in vain.

This is no exaggeration: in many cases the thickness of coatings can be appreciably reduced. The main thing required of them is an absence of pores through which moisture, oxygen from the air or other substances causing corrosion can penetrate. This can be achieved by different methods. We know, for example, that the higher the degree of surface finish of an item, the tighter the protective film will be. It follows from this that coating thickness can be reduced by preliminary treatment, and especially by employing methods of chemical and electrochemical polishing.

Modern methods of applying coatings can also substantially reduce porosity. In particular, the so-called reversing process, whereby the direction of current flow is periodically changed in the electroplating bath. With this technique one can obtain practically nonporous copper films only 7 microns thick, and nickel films 15 microns thick. Even better results are obtained with metal deposition in an ultrasonic field. In this instance the same nickel films, with a thickness of 8-10 microns, contain practically no pores, while the process itself takes place significantly more rapidly. Finally, the Institute of Chemistry and Chemical Technology of the Lithuanian SSR Academy of Sciences has developed methods of applying two- and three-layer nickel films with a decorative luster, the corrosion resistance of which is 4-6 times greater than single-layer coatings of the same thickness. The need for mechanical polishing of the film is also eliminated, a process which results in loss of up to 20 percent of the applied metal.

Thus one can state with confidence that, thanks to research and development in recent years, a fairly extensive arsenal of methods has been developed, which make it possible substantially to improve the quality of protective-decorative coatings and, reducing their thickness, to save a large quantity of short-supply nonferrous metals. Unfortunately, however, the majority of the above-enumerated advanced processes have not yet left the laboratory. Electroplating shops at the great majority of enterprises are continuing to combat porosity with the hoary method of coating products deliberately with thick films, viewing them as the sole guarantee against corrosion. For them problems of achieving savings in nonferrous metals do not exist, as it were.

We should not, however, be hasty in throwing accusations in the direction of the persons in charge of these shops and enterprises. A paradoxical situation has been created: it does not make sense for production people to improve electroplating technology. The fact is that all currently applicable state standards and technical specifications require application of protective-decorative coatings of an excessive thickness -- from 12 to 30 microns. In other words, any item coated with a film of less thickness, even if it provides the required protective properties, should be rejected as substandard. And this is the prevailing situation at a time when some countries are already planning to transition over to films only 6 microns in thickness!

When these state standards and technical specifications were adopted, they played a definite positive role. At that time sufficiently reliable methods of applying coatings were not known. And in order to ensure reliable protective properties, it was necessary deliberately to make economic sacrifices. But today the situation has changed radically. And obsolete standards have become an impediment in the path of technological advance in the electroplating industry.

The most troublesome thing is that these state standards and specifications have had an extremely adverse effect on the technological level of electroplating equipment

manufactured in this country. The Tambov Plant, for example, in spite of elements of automation and mechanization, is in fact turning out yesterday's equipment. Nor are things any better as regards electrical equipment. Manufactured in Mordovia and Kirghizia, it does not meet today's technology requirements.

A sort of vicious circle has been created: electroplating facilities cannot change over to advanced processes, because there is no suitable equipment available to do so. And there is no need to produce new equipment, since current standards do not permit any innovations. It would seem to be obvious: USSR Gosstandart is to blame! But this would be too hasty a conclusion. The position taken by this committee, which stubbornly demands employment of thick, "quality" coatings, is dictated to a certain degree by the endeavor to protect electroplating facilities from all kinds of chance occurrences, including substandard product caused by crude organization of the production process.

In many countries, for example, industry has long since changed over to ready dry compositions supplied by specialized companies. All the customer has to do is dilute them in electroplating baths with a specified amount of water, and they will ensure an optimal electroplating process. In this country electroplating shop personnel still frequently make up such mixes by hand, and sometimes without the use of precision batching equipment, and in addition with a low level of personnel qualifications. Errors are practically inevitable under the circumstances. Rigorous observance of process requirements, quality of applied coatings, and savings in short-supply nonferrous metals are out of the question.

As a consequence, this situation in the electroplating industry leads to losses many of which could easily been avoided. In particular, there is the reclamation or recovery of nonferrous metals from electroplating shops' spent electrolytes and wastewater. The amount of reserve potential here is indicated by the results of a survey of 144 enterprises of Minpribor [Ministry of Instrument Making, Automation Equipment and Control Systems]. They have shown that with the aid of reclamation and recovery, these enterprises can return 380 tons of chromium, 310 tons of nickel, 180 tons of zinc, 63 tons of copper, 23 tons of cadmium, and 15 tons of tin. And yet these enterprises represent less than 4 percent of total electroplating output volume.

We must emphasize that in addition to considerable savings in nonferrous metals, recovery makes it possible to make electroplating processes waste-free to a certain degree, simultaneously solving the problem of environmental protection. But at the present time efficient recovery methods are only at the development stage at various laboratories. And many of these laboratories are working only for "their own" industry, frequently retracing the same path of discovery already accomplished at another institute. This fact only serves to reemphasize that in such mass-production industries as electroplating there is no single entity capable of implementing a unified scientific, technical and organizational policy.

"...Develop and adopt highly-efficient methods of improving the strength properties and corrosion resistance... of metals and alloys, metal structures and pipe," reads the target in the Principal Directions of this country's economic and social development adopted at the 26th CPSU Congress. Improvement in the technological level of electroplating facilities is one of its component parts. But the intersectorial character and multiple level of problems connected with them indicate that they can be resolved only through the joint efforts of the USSR State Committee for Science and Technology, the USSR Academy of Sciences, and interested ministries and agencies.

In view of the pace of growth and development of the electroplating industry, we must immediately proceed with taking measures to achieve more precise coordination of scientific research activities, revise present standards and technical specifications in order to reduce sharply the thickness of coatings, while achieving increased corrosion resistance, and organize the manufacture of new kinds of equipment, power supplies and ultrasonic equipment, as well as ready electroplating mixes. We believe that all this can be successfully accomplished only within the framework of a specific-purpose integrated program aimed at achieving a qualitative leap forward in the electroplating industry.

3024
CSO: 1842/110

REFINING AUSTENITIC STAINLESS STEELS TO INCREASE THEIR LOCAL CORROSION RESISTANCE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 81 pp 2-9

KOLOTYRKIN, Ya. M. and UL'YANIN, Ye. A., Scientific Research Physico-Chemical Institute imeni L. Ya. Karpov and All-Union Intersector Scientific Research Institute for Corrosion Protection of Metals

[Abstract] Alloying with the appropriate elements was investigated to increase the local corrosion resistance of austenitic stainless steels. Various alloying elements such as phosphorus, silicon, boron, molybdenum, nitrogen, manganese and sulphur were introduced to various types of austenitic steels to investigate their corrosion stability, cracking, transcrystallite corrosion cracking and pitting corrosion of steels. The alloying additives are used primarily to compensate for the negative effects of impurities. This method of refining stainless steels contributes to an increase of service and production properties as well as economizing on scarce alloying elements. Figures 8; references 24: 18 Russian, 6 Western. [105-6521]

UDC 620.193.01

EFFECT OF SULFUR ON THE OXIDATION RATES OF TUNGSTEN AND TITANIUM IN THE O_2+CO_2+SO_2 GAS MIXTURE

Moscow ZASHCHITA METALLOV in Russian Vol 17, No 3, May-Jun 81 pp 351-354 manuscript received 25 Apr 80, after completion 22 Oct 80

SUNTSOV, N. V., ZHURAVLEV, N. L. and MILOSLAVSKIY, A. G., Donetsk State University

[Abstract] A sulfur impurity in n-TiO_2 and n-WO_3 oxides with a defective structure has been found to behave as a donor or an acceptor, depending on the concentration of anionic vacancies. The transition from donor behavior to acceptor behavior has, moreover, been found to occur at a composition which comes closer to the stoichiometric one as the temperature rises (at 1073 K under a pressure P_{O_2} = 14.5 kPa in TiO_2 and at 1103 K under a pressure P_{O_2} = 200 Pa in WO_3). Here

these trends are described by quasi-chemical reactions between an oxide crystal and gaseous SO_2 with subsequent ionization of sulfur. A study of the kinetics of titanium and tungsten oxidation in the $O_2 + CO_2 + SO_2$ mixture at temperatures from 1073 to 1173 K, under pressures P_{O_2} from 10^2 to 10^5 Pa and P_{SO_2} from 0 to 10^4 Pa, has revealed that the oxidation process in both cases follows the parabolic law from beginning to end. Metallographic and x-radiographic examination have confirmed the phase composition of titanium and tungsten oxides, a second not yet definitively determined phase coexisting with WO_3. Figures 3; references 10: 6 Russian, 4 Western.
[121-2415]

UDC 620.195

EFFECT OF BIOGENIC ELEMENTS ON THE CORROSION OF METALS IN THE ATLANTIC OCEAN

Moscow ZASHCHITA METALLOV in Russian Vol 17, No 3, May-Jun 81 pp 334-336
manuscript received 20 Feb 80, after completion 23 Apr 80

ULANOVSKIY, I. B. and YEGOROVA, V. A.

[Abstract] Several metals (grade AV-000 aluminum, grade M1 copper) and alloys (St3 carbon steel, AMg6 aluminum-magnesium alloy, L63 brass) were tested in three solutions corresponding to Atlantic Ocean surface water continning biogenic elements in the minimum amount (3 μg-atom/l Si, no NO_2^- and NO_3^-, 0.1 μg-atom/l NO_3^-, 0.5-1.0 μg-atom/l NO_2^-, 1-2 μg-atom/l PO_4^-). The effect of each ingredient as well as their combined effect on the corrosion rate of these materials were measured. While the corrosion rate of aluminum, copper, and their alloys increases monotonically with increasing concentration of silicates, nitrites in small concentrations do not affect the corrosion rate of all these materials except brass (which they increase), nitrates decrease the corrosion rate of steel but increase the corrosion rate of all other materials, and phosphates in high concentrations decrease the corrosion rate of steel but hardly affect the corrosion rate of brass, the combined effect of all ingredients is an overall higher corrosion rate of all these materials here than in the Pacific Ocean or in the Black Sea. The magnitude of this effect is very sensitive to changes in the concentrations of Si, N^{III}, N^{V}, P. References 9: 7 Russian, 2 Western.
[121-2415]

UDC 624.197.2

BREAKDOWN VOLTAGE AND PROTECTIVE CHARACTERISTICS OF OXIDE FILMS ON TITANIUM

Moscow ZASHCHITA METALLOV in Russian Vol 17, No 3, May-Jun 81 pp 318-321
manuscript received 24 Mar 80

SAVOCHKIN, V. R. and NAGAY, I. N.

[Abstract] Oxide films on titanium which form during anodic or heat treatment improve its corrosion resistance in acids and in liquid bromium. A study was made to determine their composition and thickness as well as their breakdown voltage and protective characteristics in 40% H_2SO_4, in 16% H_2SO_4 + 1.3% HCL + 17.6% HBr, and in liquid elementary Br (with 0.03% moisture and 0.02% organic impurities). After buildup, the films were removed from the surface by a cathode current of 1.5 A/cm^2 in 20% H_3PO_4 + 0.1% CrO_3 at 80°C and the bare titanium surface intentionally scratched. The phase composition of films was analyzed by the powder method with a CuK_2 radiation source. The breakdown voltage was measured in 3% NaCl relative to a steel cathode holding the reference voltage for 3 min. The protective characteristics of the films were found to be determined neither by the phase composition nor by the thickness, but by the breakdown voltage. The best protective characteristics in all three media were found to have TiO_2 (rutile) films building up to a 4-7 μm thickness at 700°C in air, with a breakdown voltage of 25-45 V correspondingly. Rutile films had somewhat worse characteristics, building up to a 2.5 μm thickness at 600°C in air, with a breakdown voltage of 18 V. Films of TiO_2 (anatase) building up to thicknesses of 0.015, 0.15, and 1.5 μm in 10% CrO_3 at 101°C, in 56% HNO_3 at 115°C and in 18% H_2SO_4 at 80°C respectively exhibited relatively poor protective characteristics in all three media, as did TiO_2 (rutile) films building up to a 25-35 μm thickness at 800°C in air and Ti_4O_7 films building up to a 0.2-0.4 μm thickness at 500°C in air. At two chemical bromium production plants, Sakskiy and Perekopskiy, condensers with enamel coating and a service life of not more than 3 months are now being replaced by condensers made of titanium oxidized at 700°C and lasting longer than 2 years. References 10: 9 Russian, 1 Western.
[121-2415]

UDC 621.193

CORROSION RESISTANCE OF MATERIALS IN BOILING SULFURIC ACID AND PRODUCTS OF ITS DECOMPOSITION

Moscow ZASHCHITA METALLOV in Russian Vol 17, No 3, May-Jun 81 pp 290-294
manuscript received 22 Apr 80

SAVITSKIY, Ye. M., ARSAKAYA, Ye. I., LAZAREV, E. M., KOROTKOV, N. A., VERESHCHAGIN, Yu. I. and KOMAROV, N. V., Institute Metallurgy, USSR Academy of Sciences

[Abstract] Thermochemical processing based on decomposition of sulfuric acid is an inexpensive method of hydrogen production. The necessary equipment consists of a thermolyzer operating at 600-900°C, a container operating at 100°C, and an electrolyzer. While conventional materials can be used for the latter two devices, special materials with an adequate corrosion resistance must be selected for the thermolyzer. Several grades of alloy (nickel) steel were tested for this application in boiling 94% H_2SO_4 concentrate at 350°C (liquid corrosion) for 10 hr as well as in an $SO_3 + SO_2 + O_2 + H_2O$ atmosphere at 600-900°C (gaseous corrosion) for 20 hr. The corrosion rate was measured by the weight method, surface layers were examined by electronography and x-ray diffraction, the redistribution of alloying elements and medium components was tracked with an Auger spectrograph and a 4-grid analyzer (primary electron beam 3 kV - 40 mA, probe area 0.001 cm^2, recording rate 1.5 eV/s). The main solid corrosion products were found to be NiO, NiS and $NiSO_4$. Noteworthy was the extremely low resistance of carbon-pyroceramic, among a few other materials also tested, to gaseous corrosion. Grades V1950, KhN45Yu and KhN65MV were found to have the highest resistance to gaseous corrosion, only grade KhN45Yu having a high resistance to liquid corrosion. The corrosion resistance of grade 12Kh18N10T steel was improved appreciably by implantation of He^+ or Ni^+ ions, to a lesser degree by implantation of Cr^+, Al^+, Pb^+ ions, in an accelerator through bombardment with 40 keV ions (10^{17} or $5 \cdot 10^{17}$ ions/cm^2 corresponding to 10 or 20 $\mu A/cm^2$, respectively). Figures 4; references 14: 9 Russian, 5 Western.
[1]1-2415]

UDC 666.232.6

ALUMINUM-MAGNESIUM SPINEL FOR TRANSLUCENT CERAMICS

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 17, No 5, May 81 pp 896-901 manuscript received 11 Dec 79

SOKOL, V. A., BOKHLENKO, D. A., KONONOVA, L. I. and BROMBERG, A. V.,
All-Union Scientific Research Institute of Chemical Reagents and Ultrapure Chemical Substances

[Abstract] An experimental study was made to compare three methods of producing stoichiometric aluminum-magnesium spinel for translucent ceramics. Specimens were produced by homogeneous codeposition of hydroxides (mixing $MgCl_2$ and $AlCl_3$ in the Mg:Al = 1:2 ratio, dissolving the mixture in distilled water at 80°C, adding the solution to an aqueous solution of NH_3 (pH = 9.5-10) at a controlled rate at 80°C, cooling the suspension to 20°C, then rinsing and drying the sediment at 100°C), by heterogeneous codeposition of hydroxides (dissolving $MgSO_4 \cdot 7H_2O$ and $Al_2(SO_4)_3 \cdot 18H_2O$ in distilled water, correcting the solution to an $MgO:Al_2O_3 = 1 \pm 0.02$ ratio, evaporating it at 102-104°C, and crystallizing the sediment), and by calcination of salts (solid state synthesis of sulfates at 1200°C having been found to be most efficient and to become less efficient at both higher and lower temperatures). The completeness of conversion to spinel was indicated by the amount of residual free MgO, the quality of specimens was monitored by electron-microscope examination and differential thermogravimetric analysis. The easy recrystallizability of spinel powders at relatively low temperatures (1400-1600°C) makes them particularly suitable for sintering under pressure, a ceramic product having been thus obtained containing 99% spinel and consisting of particles not larger than 0.4 μm. Figures 4; references 15: 9 Russian, 6 Western.
[122-2415]

UDC: 678.620.171.32

MECHANICAL PROPERTIES OF CERTAIN GLASS-REINFORCED PLASTICS AT LOW TEMPERATURES

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 81 pp 64-68
manuscript received 19 Dec 79

IL'ICHEV, V. Ya., VLADIMIROVA, V. L., TELEGOW, A. I. and MASLIY, G. I.,
Physico-Technical Institute of Low Temperatures, Ukrainian Academy of Sciences,
Khar'kov

[Abstract] A study is made of the influence of temperature on the mechanical properties of glass-reinforced plastics. The strength characteristics of 11 types of glass-reinforced plastics made with epoxy and phenol-formaldehyde resins were studied. The specimens were reinforced with both randomly oriented fibers and glass fabric. The variation of the strength properties of the specimens with temperature was studied at 4.2 to 423°K on a low-temperature tensile-testing machine. The influence of stress concentrators consisting of circular apertures 2 mm in diameter was also studied. The specimens were loaded at 1 mm/min after holding in the cooling agent (nitrogen, hydrogen, helium) for 30 minutes. The modulus of elasticity was found to increase by an average of 15%. The tensile, compressive and bending strength increased down to 77°K, below which the performance of the specimens was unstable, although tensile strength at 4.2°K was higher for practically all specimens than at room temperature. Glass-reinforced textolite with fabric reinforcement was the strongest of all specimens tested. The stress concentrators have little influence on strength. Figures 5; references 5: 2 Russian, 3 Western.
[95-6508]

GEOLOGICAL PROBLEMS FACING 11TH FIVE-YEAR PLAN

Moscow SOVETSKAYA ROSSIYA in Russian 22 Apr 81 p 4

[Article by Prof A. Malakhov, doctor of geological-mineralogical sciences, Sverdlovsk Institute of the National Economy: "New Facts About the Old Urals"]

[Text] Tasks assigned the workers of the Urals by the 26th CPSU Congress include continuing renovation and retooling of enterprises of the mining and nonferrous metallurgical industries, machine building, the chemical and petrochemical industry, as well as strengthening the raw materials base of nonferrous metallurgy. In connection with this, SOVETSKAYA ROSSIYA correspondent B. Baydakov asked Prof A. Malakhov, Doctor of Geological-Mineralogical Sciences at the Sverdlovsk Institute of the National Economy, to discuss the development of Urals geology and the problems it will be addressing in the 11th and subsequent five-year plans.

A geological map of the Urals is marked out with all the colors of the rainbow.... A great many prospecting and exploration expeditions, parties and detachments, teams of geologists, geophysicists, and geochemists are at work in this region. In parallel with the mobile detachments, an assault on the mineral resources of the Urals is also being mounted by drilling crews and geophysicists. Of the 55 commercial minerals produced in the USSR, the presence of 48 has been determined in this region! It would seem that no stone remains unturned for the investigators. Does this mean that there is nothing new to be discovered?

Forgotten Sensational Discoveries

One was born in the air. N. Surgutanov, a pilot for the Urals Territorial Geological Administration, was making regular flights between Sverdlovsk and Kustanay. And on each flight he would drift off course at the same place -- his compass would give wrong readings. Surgutanov was puzzled. Once he decided to mark the location: he flew over it at treetop level and dropped a marker flag at the spot. Back in Sverdlovsk, this pilot urged that somebody go to check out the location. Geologists and geophysicists established that there was a body of high-quality magnetite at this location. Exploitation of this ore body commenced.

Today few people remember that there once stood two small villages, Sokolovka and Sarbayka, where today the city of Rudnyy stands. Surgutanov's marker flag landed between these two villages. By 1959 the city had a population of 33,000, and

107,000 by 1975! The city contains a mining and beneficiation combine, food processing industry enterprises, an affiliate of the Kazakh Polytechnic Institute, an industrial arts school, a music school, and a school of education.

Another "iron boom" began at ...the Sverdlovsk Uralmekhanobr Institute. The institute staff has taken the research baton from the geologists. Sometimes they are also interested in that which the geologists reject as useless. For example, their attention was drawn by pieces of a dark-colored rock -- gabbro -- from the vicinity of Kachkanar Mountain. If one closely examines the Kachkanar gabbro, one can note gleaming specks of titanomagnetite -- an ore containing both iron and titanium. But the iron content is only 16 percent, and the titanium content is even less. A genuine high-grade ore should have a two thirds iron content. The engineers and scientists at Uralmekhanobr themselves "created" an ore deposit. They proposed that the gabbro be pulverized, after which the iron-containing powder would be drawn off in a vacuum by powerful electromagnets. The result was an excellent raw material for the metallurgical industry, with a resource of more than 4 billion tons, calculated in concentrated ore, available in the area of Kachkanar Mountain!

Sensations upon sensations.... In different years they made the Urals into a rich source of iron, copper, and bauxite.... But this was happening with less and less frequency. Questions arose. Are the Urals becoming minerals-impoverished? Could it be that we are being let down by traditional theory? Should the causes not be sought in prospecting methods?

Corrections to Theory

Let us return to our map of the Urals. Periodically corrections are made. They are clearly evident, for example, if one compares the second and third editions of the Great Soviet Encyclopedia, although the general, overall scheme remains the same.

Some teams of investigators propose to update the map, and fairly substantially. For example, one should bear in mind that at various stages of formation the Urals were not only meridional -- they are intersected by a number of epigenic structures. Take the Timanak-strike folds, for example, which approach the mountains, "dive" under them and resurface near the city of Kokchetav. Even more spectacular is the Kirovsko-Khanty-Mansiyskaya latitudinal structure (groups of anomalies), which extends 1,500 kilometers under the surface.... But in order to base prospecting and exploration (including for oil) on this scheme, it is necessary to reject a number of customary concepts. And that is not so easy to do....

I. S. Ogarinov, a geophysicist from Ufa, has elaborated in particular detail the scheme of deep tectonics of the Urals. It is being used, and with a fair amount of success, by the Bashkir oilmen. In view of their experience, it would not be a bad idea to extend this scheme to the entire Urals.

Another quite spectacular correction to the traditional theory has been proposed by scientists at the Sverdlovsk Institute of Geology and Geochemistry of the USSR Academy of Sciences Urals Scientific Center, headed by Corresponding Member of the USSR Academy of Sciences S. N. Ivanov. They take cognizance of today's popular hypothesis of horizontal migrations of the continents and ocean floor. The facts

are astounding. As studies have indicated, two mountains -- Vyazovaya and Mayachnaya near the town of Nyazepetrovsk... have "crawled" into this area. Their mass is more than 20 billion tons! So many beds weighing hundreds of trillions of tons, which have shifted dozens of kilometers, have now been established in the Urals that this has enabled a team directed by S. N. Ivanov to examine from an unusual point of view the history of the origin of the Ural Mountains and to explain from this conceptual viewpoint the reasons for the failure of many mineral exploration efforts.

Or take another example. Doctor of Geological-Mineralogical Sciences N. P. Malakhov discovered in granite-like rocks in the Urals traces of petrified remains of Carboniferous and Devonian fauna! Their discovery in these rocks restates the question of the principles of concentration of commercial minerals. It becomes clear why many attempts to find mineral raw materials in granite have proven fruitless.

"Open Sesame!"

The range of problems occupying the attention focus of Urals investigators is fairly extensive. In particular, the Principal Directions focus considerable attention on the necessity of environmental protection and rational utilization of natural resources. But at many copper and iron ore deposits in the Urals we discard as tailings (and essentially lose) rich accumulations of extremely important elements -- impurities. This was described in a rather picturesque manner in a newspaper article. "What would you say," wrote the author of the article, "if you encountered a person gathering potatoes into a basket while casting aside gold nuggets found among the potatoes?" When this "harvester" was asked why he was doing this, he replied: "My plan calls only for potatoes."

It is not surprising that in recent years there has been an increasingly more persistent appeal for thrifty, efficient utilization of all components of ore and non-ore deposits. At the same time there should be more extensive utilization of strip-mining overburden and removal of coal bed and salt deposit spoil banks. This is an enormous national problem directly linked with protection of the environment!

It is no less important to concentrate geological exploration to the east of the Urals. Geological surveys indicate that in this region rocks lie concealed under young Meso-Cenozoic sediments. The underground riches of Rudnyy, for example, were discovered lying under these sediments. Other sensational finds are also possible. Also highly promising is prospecting the Northern and Arctic Urals, many areas of which have not yet been touched by detailed investigations.

In addition to the eastern and northern areas, one can also mention the area deep below the surface. I am sure that a genuine "Great Urals" lies untouched down there. I believe that particularly interesting from the economic point of view are the zones of the structures cutting through the Urals, those which I have already mentioned as well as others which are covered by complex rock units.

The broad front of potential areas of investigation suggests that the prospects of future discoveries of major deposits of mineral raw materials needed by our country are practically unlimited. No, the Urals have not become impoverished! What is needed is merely a persistant search, based on new methods.

A True Fairy Tale

In the Southern Urals, near the city of Miass, there is a remarkable place where nature gathered together dozens of diversified minerals. Here, on the recommendation of Academician A. Ye. Fersman, the world's only mineralogical preserve was established by a Lenin decree. When one takes a look at the mining operations in this preserve, dating from the beginning and middle of the last century, one is amazed by how many of them were begun deep in the heavily-forested taiga without preliminary exploratory prospecting and yet hit the bull's-eye -- a cavity containing precious stones! How were these old mineral prospectors able to do it? Evidently they were using a "divining rod" -- that amazing instrument of the past....

I do not want to give the impression that I am calling for a return to the methods of our forebears, although it is useful to take a look at them. We need tools based on the highest achievements of science, which would enable today's drilling rigs immediately to strike large deposits of mineral raw materials buried tens and hundreds of meters under the ground. One might reply that modern geophysical instruments make it possible to accomplish this. Yes, their employment in relatively simple geologic conditions, such as in Western Siberia, brings success. But this same equipment sometimes produces ambiguous results in the conditions of the Urals, which possess complex structure, are folded and heavily faulted.

I shall cite as an example the results of scientific processing of cores from a borehole drilled not far from Zlatoust. Rocks which are from 1.8 to 2 billion years in age crop out in this area. But at a depth of 593.4 meters, under these ancient rocks, the drill bit suddenly encountered relatively young, bituminous limestones, with well preserved fauna, extending to a vertical thickness of approximately 300 meters! A scientific examination of the fossils indicated that they date from the Devonian period of the Paleozoic era, that is, these sediments were laid down "only" about 400 million years ago. It is like walking down into basement and ending up on the roof.

And since the Devonian limestones proved to be bituminous, under suitable structural conditions one could hit oil! Of course it would be a good thing if one could locate this structure initially from the surface. A device which can "see through the ground" would come in handy. A fairy tale? For the time being, yes. But I believe that such a device will become reality. What is needed is merely a closer alliance between science and production, which the party is directing us to accomplish.

The device I am dreaming about would make it possible to produce geologic maps -- sections at depths of 100, 200, 300 meters and deeper, indicating the accumulation sites of various commercial minerals. Then drilling rigs would "strike" new and promising deposits of mineral raw materials practically without a miss. Other special maps produced in the same manner would establish the depths of occurrence of structures of "non-Urals" trend. At Sverdlovsk such structures are possible at comparatively easily reached depths. They may contain concentrations of hydrocarbons, geothermal waters, and bauxites. In other areas of the Urals there may lie copper and high-grade iron ore bodies as well as deposits of many other minerals. If these forecasts prove out, the economy of the "nation's smithy" will be taking a great step forward.

3024
CSO: 1842/98

UDC: 546.763;539.4;661.55;548.73

STATUS OF STUDIES OF THE PROPERTIES OF TRANSITION METAL NITRIDES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 81 pp 77-87
manuscript received after revision 30 Aug 80

ANDRIYEVSKIY, R. A., Moscow Institute of Fine Chemical Technology imeni Lomonosov

[Abstract] A review is presented of the world literature on the properties of transition metal nitrides. At the present time, primary attention is being given to the nitrides of boron and silicon. Since 1965, national Soviet seminars have been held on nitrides. The literature on the subject is rather extensive. However, in spite of the abundant literature, the status of information on the physical-chemical and physical-mechanical properties of the transition metal nitrides is hardly complete. There is little information on the state diagrams of transition metals plus nitrogen. The situation has remained practically unchanged since 1972. The question of the melting point of the transition metal nitrides in groupd III-V has not been fully clarified. Further accumulation of data on the thermodynamic and diffusion characteristics of nitrides is necessary. The studies which have been performed on the mechanical properties of nitrides represent only a beginning, since many aspects of the problem of the strengths of nitrides remain practically untouched. The electron structure of transition metal nitrides has been more completely studied. The state diagrams of transition metals plus nitrogen must be refined over a broad range of pressures. Figures 10; references 103: 86 Russian, 17 Western.
[99-6508]

UDC: 621.762

RELATIONSHIP OF ELECTRON STRUCTURE TO ELECTROPHYSICAL PROPERTIES OF NITRIDES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 81 pp 73-76
manuscript received after revision 30 Aug 80

ANDREYEVA, T. V., GORYACHEV, Yu. M. and KOVENSKAYA, B. A., Institute of Problems of Material Science, Ukrainian Academy of Sciences

[Abstract] Calculation of the electron structures of the nitrides of s-p and d elements is used to analyze the formation of their electrophysical properties.

Differences in the behaviors of the two states are demonstrated and the position of nitrides among compounds of other classes is studied. Comparison of s-p and d elements with oxides and carbides shows that the s-p elements are dielectrics which follow the rules of valent compounds, while the d elements are metal-like with deviations from stoichiometry over broad areas of homogeneity. The electron energy spectrum was used to calculate the parameters of the electron structure: energy of transition to the plasma state, atomization energy of a fragment, charge of an atom and energy separation between occupied and filled states. The nitrides occupy an intermediate position between the carbides and the oxides in their electron properties. The electron energy spectrum is explained by the semiconductor properties of the s-p elements and the appearance of the metal and semi-metal properties of the d element nitrides. A regular change in properties from semimetallic to metallic is observed in the sequence of scandium-titanium nitrides. Figures 4; references 6: all Russian.
[99-6508]

UDC: 621.762

METASTABLE STATE DIAGRAMS OF TWO-COMPONENT SYSTEMS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 81 pp 56-59
manuscript received 28 Nov 80 after revision

FEDOROV, V. B., GURSKIY, M. A., KALASHNIKOV, Ye. G., LAPOVOK, V. N., SHORSHOROV, M. Kh. and TRUSOV, L. I., Ul'yanov State Pedagogic Institute

[Abstract] An analysis is presented of phase equilibria of systems in the ultradispersed state. Lines of phase equilibrium of the transition from the dispersed to the liquid state or from the amorphous to the crystalline state are determined for single-component systems. The lines of phase equilibria for single-component systems can be estimated in an approximation considering changes in entropy of the ultradispersed system and redundant surface energy. As an example, a eutectic system is studied in which one of the phases is dispersed, such as Al-Si, Ni-C, Ge-Ge or Sn-Bi. A second example calculated is a system with an intermediate zirconium carbon phase. The eutectic points can be determined from the minima of lines describing equality of the thermodynamic potentials of the liquid phases in areas I and II. Calculated and experimental results agree satisfactorily, confirming the lowering of the eutectic point due to the redundant surface energy of the carbon in the example system. Figures 2; references 5: all Russian.
[99-6508]

UDC: 621.793.7

SYSTEMIC ANALYSIS OF DETONATION PULVERIZATION OF COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 81 pp 24-31
manuscript received 5 Mar 80

KHARLAMOV, Yu. A., Voroshilovgrad Institute of Machine Building

[Abstract] Detonation-gas spraying is a process based on complex, poorly understood physical-chemical processes which depend on large numbers of parameters. A stricter statement of the task of optimization of technological processes of such spraying is required. This in turn requires establishment of a number of variables, their limitations and evaluation criteria. This article studies the most important connections which exist between the individual elements in a structural diagram of the process. Elements included are the work piece, quality of surface, initial powder, detonation installation, detonated gas mixture, spraying conditions, final status of the powder, interaction of detonation gas jet and substrate, interaction of powder with substrate, filling of the column with gas and powder, quality of coating, sealing parameters of part, productivity and economy. Most of the connections noted have been little studied or remain completely unstudied. The development of a mathematical model of such a complex process requires deeper study of the nature and mechanism of the physical and chemical phenomena occurring during application of coatings. This article merely outlines the interconnections which must be further investigated before an approach can be made to the development of such a model.
[96-6508]

UDC: 669.046:66.063.5

CONTACT INTERACTION OF TITANIUM CARBIDE WITH IRON-BASED ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 81 pp 66-72
manuscript received 1 Sep 80

PANASYUK, A. D., KYUBARSEPP, Ya. P., DZYKOVICH, I. Ya. and VAL'DMA, L. E., Institute of Problems of Material Science, Ukrainian SSR Academy of Sciences

[Abstract] In order to determine the influence of the addition of nickel, silicon and chromium on the wetting kinetics and nature of phases formed at the contact zone when titanium carbide interacts with iron-based alloys, the authors studied the interaction between phases of titanium carbide and Fe-Ni, Fe-Si and Fe-Cr. The contact wetting and angles were determined at 1500°C under a vacuum, with subsequent microstructural analysis of the contact zone. Photomicrographs illustrate the contact zones of interaction. It is found that the addition of Ni, Cr and Si improves adhesion of iron to titanium carbide, acting as interphase-active elements, and facilitates the formation of a heterophase, fine-grained structure at the contact zone of interaction. Figures 7; references 6: all Russian.
[96-6508]

UDC: 620.178.38:669.15'25-194

LOW-CYCLE IMPACT FATIGUE OF N18K9M5T STEEL WITH TWO PHASE ($\alpha+\gamma$) STRUCTURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 81 pp 28-31

PESTOV, I. V., MALOLETNEV, A. Ya., PERKAS, M. D. and YEDNERAL, A. F.

[Abstract] Results are presented from a study of the low cycle impact fatigue properties of N18K9M5T steel (0.01% C; 18.2% Ni; 9.0% Co; 4.8% Mo; 0.75% Ti; 0.09% Al; ≤0.05% Si and Mn; ≤0.007% S and P). The specimens for the test were heated at 20°C/min to 820°C, held for 5 minutes, then cooled in air. The number of heating and cooling cycles was varied from 1 to 5. The specimens were then aged at 490°C. Fatigue tests were performed by repeated drop hammer loading at 10 cycles per second. Diffraction electron microscopy of thin foils on an electron microscope was used to study the structure of the steel. Two factors are primarily responsible for stabilization of the austenite in the structure of the steel: diffusion redistribution and the small dimensions of the austenite crystals formed. The thermal cycling which stabilizes the dispersion of the residual austenite leads to an increase in low cycle impact fatigue resistance. As cyclical stress increases, the influence of deformation γ to α transformation decreases. Thermal cycling can thus be recommended as a method of increasing the structural strength of martensite aging steel parts. Figures 4; references 10: 9 Russian, 1 Western.
[100-6508]

UDC: 620.17:621.78:669.14.018.295

PROPERTIES OF MARTENSITE AGING STEELS AFTER HIGH TEMPERATURE TREATMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 81 pp 31-33

ABRAMOV, O. V., IL'IN, A. I. and KARDONSKIY, V. M., Institute of Solid State Physics, USSR Academy of Sciences, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] A study is presented of the influence of various high temperature treatments on the mechanical properties of high strength martensite aging steels. The studies were performed on steels with strengths after aging of over 2200 MPa. The chemical composition of the steels included: Ni 11.5 to 15.8%, Co 13.6 to 15.2%, Mo 0.93 to 6.3%, Ti 0.17 to 2.5%, W 9.2% (1 specimen) S 0.0012 to 0.0018%, C 0.02 to 0.05%, P 0.002%, Si 0.6 to 0.26%. The steels were produced in a vacuum induction furnace and homogenized at 1150°C for two hours. Mechanical testing was performed on standard and nonstandard specimens. The austenitic grain size was revealed by etching and determined by the method of secants. The optimal austenite structure is achieved by rolling at a temperature of not over 900°C, rapid heating to Ac_3+30°C and rapid cooling. Figures 3; references 5: 4 Russian, 1 Western.
[100-6508]

UDC: 539.4

FATIGUE OF EP810 STEEL AT CRYOGENIC TEMPERATURES

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 81 pp 65-67
manuscript received 25 Mar 79

DEMCHUK, I. S., ANTROPOV, N. P., SILIN, P. N., LEBEDEV, K. K. and LEBEDEVA, O. A., Leningrad Polytechnical Institute, Leningrad

[Abstract] This article studies the fatigue properties of EP810 steel: 0.02% C, 0.09% Si, 0.005% P, 0.009% S, 11.87% Cr, 9.45% Ni, 0.55% Mo, 0.20% Ti, 0.08% Al, 0.06% Zr, 0.001% B, traces of Mn. The heat treatment included primary hardening from 1000 $\pm$ 10°C, holding 40 minutes, quenching in water; secondary hardening from 750 $\pm$ 10°C, holding 40 minutes, quenching in water, followed by tempering at 250°C, holding time 2.5 hours, cooling in air. The experiments involved cantilever bending of a rotating specimen at 293, 77 and 20°K and four stress levels for each temperature, varying from 67.2 to 93.5 kgf/mm^2, loading frequency 48 Hz. Changes in phase composition and grain size of the steel are found to have a predominant influence on the nature of generation and development of fatigue cracks. As the temperature decreases the nature of fracture also changes, from viscous to more brittle. As temperature drops the homogeneity of grain size increases and grain size decreases. At 293°K grain size is reduced with an increase in load, while at 77 and 20°K the reverse is observed due to stabilization of austenite. Figures 3.
[101-6508]

UDC: 621.531.9+533.65+533.89

AUTOMATION OF THE PROCESS OF SINTERING OF SUPERHARD MATERIALS UNDER HIGH PRESSURE CONDITIONS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 81 pp 94-97
manuscript received 2 Jul 80

GROMYKO, S. N., MEL'NIK, V. M. and FRANTSEVICH, I. N., Institute of Problems of Material Science, Ukrainian Academy of Sciences

[Abstract] The process of sintering of a number of superhard materials must be automated to eliminate subjective variations in sintering parameters, which are dependent upon the operator. The use of precision control instruments guarantees high reproducibility of these parameters. In order to achieve these purposes, the authors modernized an installation for the production of superhard materials. The type D0043 device automatically controls pressure, temperature and heating power, and could be widely used for hot pressing of various materials manufactured by powder metallurgy methods. A block diagram of the automatic temperature and power regulator is presented. The best transient process in the control system is achieved by the use of proportional integral differential regulation. Operation of the device for a long period of time has shown good economic effectiveness of the modernization performed.
[96-6508]

UDC 539.216.2:538.6:538.56

ELECTROMAGNETIC WAVES IN THIN METAL FILMS IN A MAGNETIC FIELD

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 51, No 4, Apr 81 pp 679-684 manuscript received 26 Mar 80

ZELENIN, S. P., KONDRAT'YEV, A. S., KUCHMA, A. Ye. and UZDIN, V. M., Leningrad State University imeni A. A. Zhdanov

[Abstract] The fact of dimensional quantification on the propagation characteristics of cyclotron waves was investigated. The case when a permanent external magnetic field is directed perpendicular to the film surface was considered. The dispersion equation is derived to describe the motion of electrons in the film. The vector and scalar potentials of the wave field inside the film are represented by Maxwell equations. Both electrodynamic and dimensional quantification effects determine the propagation of cyclotron waves in thin films. The vibrational frequencies of the wave branches are oscillating functions of film thickness due to variation of filled energy zones. References 9: 6 Russian, 3 Western.
[107-6521]

UDC: 669.295:620.18:621.78.08

INFLUENCE OF COOLING RATE ON STRUCTURE OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 81 pp 48-49

KOVNERISTYY, Yu. K., BOLOTINA, N. P. and NARTOVA, T. T.

[Abstract] A study is made of the influence of cooling rate on the structure of two titanium alloys in the system Ti-Al-Zr-Mo and the system Ti-Al-Zr-W with a total content of alloying elements of 14%. Thermal, metallographic and x-ray phase analyses were used. The microstructure of the alloys is shown in photomicrographs. Microstructural analysis showed that at ordinary rates of quenching from 1100-1200°C the alloy with W has a large grained α' phase structure with clear martensite. Hardening from the liquid state helps to decrease the grain size by a factor of about 10. The structure of the alloy in this case is a needle-like martensite with clear grain boundaries. It is concluded that an increase in cooling rate for the alloys containing W leads to a decrease in grain size but has no influence on phase composition. Alloys in the system Ti-Al-Zr-Mo are more structurally sensitive. When hardened from the liquid state at high cooling rates the martensitic α' phase is not formed, but rather a high temperature β phase forms. Figures 1; references 6: all Russian. [100-6508]

UDC: 669.295:621.7.029:669.3

INFLUENCE OF PLASTIC DEFORMATION AND DIFFUSION ANNEALING ON THE PROPERTIES OF VT9 TITANIUM ALLOY WITH COPPER COATING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 81 pp 45-48

BEKRENEV, A. N., DUBOVENKO, I. F. and VALYUZHENICH, M. K.

[Abstract] A study is made of the phase composition, microhardness, wear and erosion resistance of surface layers of VT9 titanium alloy clad with copper

with combined plastic deformation and diffusion annealing. Specimens in the form of cylindrical washers 25 mm in diameter were studied, annealed in a vacuum of 6.65 MPa at 800°C for 4 hours then shot peened at 0.4 MPa, shot diameter 0.8-1.0 mm. Copper was sprayed onto the surface in a vacuum. The distribution of atoms of copper and titanium in the diffusion zone was studied by an x-ray micro-analyzer. Microhardness was measured in a slanted section at an angle of 2°. The specimens were tested for wear resistance. The x-ray phase analysis revealed significant changes in the phase composition through the cross section of copper coated specimen. Plastic deformation of copper coated specimens of VT9 alloy results in acceleration in processes of interdiffusion, manifested as the formation of a broader diffusion zone with improved physical and mechanical properties. Maximum hardening is observed in specimens deformed plastically both before application of the coating and after. Figures 4; references 6: all Russian.
[100-6508]

UDC: 669.295:621.785.3

PROPERTIES OF VT6 ALLOY AFTER β-ANNEALING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, Apr 81 pp 43-45

BORISOVA, Ye. A., SHASHENKOVA, I. I. and ZAKHAROVA, M. V.

[Abstract] The influence of β-annealing conditions on properties determining the efficiency of VT6 alloy in structures was studied in order to select the optimal conditions. The test specimens were cut from commercially produced plates 50 mm thick. The chemical composition of the alloy is: 5.8% Al, 3.9% V, 0.084% Fe, 0.06% Si, 0.015% C, 0.01% N, 0.12% O, 0.002% H, 0.02% Zr, 0.04% Mo, 0.02% Ni, 0.05% Cr, 0.05% Mn, 0.066% Sn and 0.004% Cu. Treatment modes included annealing at 750°C for two hours (1), 1050°C for 5 hours in a vacuum (2), and 1050°C for 1 hour plus 730°C for 2 hours (3). The results indicate that β-annealing (1 and 2) has the greatest influence on ductility characteristics, reducing them by 25-40%. Tensile strength and yield point are practically unchanged after type 3 annealing in comparison with ordinary annealing (type 1), but after extended vacuum annealing (type 2) there is a decrease in strength by about 5% and in yield by about 10%. β-annealing (2 and 3) has the greatest influence on impact toughness of specimens with cracks. Type 2 annealing resulted in a decrease in endurance when tested for 10^7 cycles, for both smooth and notched specimens. Type 3 annealing showed a significant increase in the number of cycles before appearance of a crack and before failure. The optimal combined annealing (type 3) provides the best combination of mechanical properties and reliability.
[100-6508]

UDC 621.791.754'293

WELDING OF VATS MADE OF TV4K TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5, May 81 pp 30-31

MEDOVAR, V. I., engineer, KRYUKOVSKIY, V. V., engineer, and VOLYNSKIY, V. V., candidate of technical sciences, All-Union Scientific Research and Planning Institute of Titanium

[Abstract] Some secondary titanium alloys produced by reprocessing of tailings combine a high mechanical strength with a high corrosion resistance. In an experimental study 7300 x 1650 x 5 mm panels of the TV4K alloy (Ti + 4.5-4.8% Al, 1.7-1.9% V, 0.1-0.2% Fe, 0.05% Si, 0.01-0.02% Zr, 0.02% Mn, 0.02% Mo, 0.006% H_2) were welded together, manually in an argon arc with a tungsten-lanthanum electrode and a VT1-00 (titanium alloy) rod, into electrolytic vats. Satisfactory welding seams across a 1.5-mm-wide clearance between panels were produced in two passes, ensuring the proper dimensions and adequate hermetic sealing of the joints. Such vats holding various chemically aggressive substances for galvanic processes are expected to have a longer service life and require fewer repairs than those now in use. References 1 Russian.
[120-2415]

UDC 621.791.754'293

WELDING EP718VD HEAT-RESISTANT ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5, May 81 p 30

MOZEYKO, B. Yu., engineer ISHTYKOV, Yu. V., engineer, MAKUKHIN, V. V., engineer, and SAYFIYEV, R. Z., engineer

[Abstract] Automatic argon-arc butt welding of the EP718DV alloy with a refractory tungsten electrode under optimum conditions produces a wide seam, typically 10 mm wide when 4-6-mm-thick pieces are joined. In this case the thermal influence zone is also wide, which weakens the joint, unless the welding is done in a helium atmosphere. In helium, however, the electrode wear increases and the arc position becomes unstable. Experiments have shown that these deficiencies can be eliminated

by the use of halogenide fluxes, specifically a 30% alcohol suspension of CaF_2, without the danger of hot cracking. While the resulting joints were found to be metallographically satisfactory, with adequately strong and plastic seams, addition of such a flux also lengthened the electrode life appreciably. Figures 2; references 1 Russian.
[120-2415]

UDC 621.791.4:539.378.3

CHARACTERISTICS OF JOINT FORMATION DURING DIFFUSION WELDING OF 2-PHASE TITANIUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5, May 81 pp 20-21

GEL'MAN, A. A., candidate of technical sciences

[Abstract] In an experimental study of joint formation during diffusion welding of 2-phase titanium alloys, T-beam joints were produced by a method ensuring the necessary chamfer. In the initial stage of the process there occurred a stepwise uniform buildup of the web thickness. In the intermediate stage there followed a barrel-like deformation, with the web becoming embedded in the flange plate and displacing some material from the latter. In the final stage the joint was completed with the proper chamfer. Best results were obtained with strips having a fine-grain (thin-fiber) structure, welded at 30-50°C below the $\alpha + \beta \rightleftarrows \beta$ transition point under a pressure of 4-7 kgf/mm^2 applied for 15-30 min. Subsequent static and fatigue tests revealed no visible discontinuities or strain concentrations at the level of the base metal. The process is recommended for welding sections 800-2000 cm^2 large, to produce joints with an impact strength not lower than 80% relative to that of the base material. Figures 4.
[120-2415]

UDC 621.791.09:621.785

IMPROVING QUALITY OF SPOT-WELDED JOINTS BETWEEN PARTS MADE OF TITANIUM ALLOYS WITH DIFFERENT THICKNESSES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5, May 81 pp 18-19

IL'YEVSKIY, I. I., candidate of technical sciences

[Abstract] Experiments were performed with electrically spot welded parts made of different titanium alloys with different thicknesses, 0.6 mm thick OT4 cover sheaths to 3-16-mm-thick VT 14 bushing plates, to determine the attendant heat treatment necessary for high-quality joints. Thermodiffusion at 960°C for 30 min under a vacuum of 10^{-4} mm Hg was found to remove the separation line inside the fusion ring. Best results are attainable by simultaneous diffusion soldering outside the welding zone. Figures 3; references 3: all Russian.
[120-2415]

UDC 621.791.763.1

SELECTION OF SPOT WELDING PARAMETERS FOR A COMPOSITE MATERIAL DEPENDING ON ITS BORON-FIBER CONTENT

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 5, May 81 pp 17-18

RYAZANTSEV, V. I., candidate of technical sciences, FEDOSEYEV, V. A., engineer, and YASTINA, N. V., engineer

[Abstract] A study was made to determine the spot welding parameters for three composite materials containing respectively 20, 33 and 55 vol.% boron fibers in an aluminum matrix, the first two produced by hot rolling and the last one produced by diffusion welding. Strip specimens 0.8-2.0 mm thick were tested and welding the first two materials by the conventional process used for D16T aluminum alloys was found to be adequate, possibly with a somewhat larger contact force and a higher welding current. Welding the third material, with a high content of extremely stiff boron fibers, would require a 25-40% larger contact force and a much higher welding current with a special design of the electrodes. This is hardly feasible, at least very difficult to achieve. Figures 2; references 3: all Russian.
[120-2415]

UDC: 621.791.021:669.295

DEVICE FOR APPLICATION OF REAGENTS TO SURFACES OF TITANIUM TO BE WELDED IN ORDER TO PREVENT POROSITY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 81 p 39

MATYUSHKIN, B. A., candidate of technical sciences, and REDCHITS, V. V., candidate of technical sciences

[Abstract] One promising measure for preventing porosity in welding of titanium alloys is the application of chemical reagents. This work studied a method for effective treatment of surfaces to be welded and developed a device for application of reagents to edges before welding. The surfaces are treated with a mixture of metal particles and the reagent as a finely ground powder in a stream of compressed air at 4 to 6 atm. gage. The metal particles deform the surface plastically and the reagent particles penetrate the surface layer of the metal. The reagent used was CaF_2, the metal particles were chips of VT20 alloy at 1:10 weight ratio of reagent to metal particles. Less than 1 milligram of CaF_2 per square centimeter was sufficient to prevent porosity upon argon arc welding. The strength of the metal treated should be 15 to 20% less than that of the metal particles used.
[94-6508]

UDC: 621.791.052:539.4.014:621.791.76:621.7.044.2

BASIC REGULARITIES OF FORMATION OF RESIDUAL STRESSES IN BIMETALLIC AND MULTILAYERED JOINTS OBTAINED BY EXPLOSIVE WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, Apr 81 pp 10-12

POKATAYEV, Ye. P., candidate of technical sciences, SEDYKH, V. S., doctor of technical sciences, GONCHAROV, A. F., engineer, TRYKOV, Yu. P., candidate of technical sciences, and YEROKHIN, A. V., engineer, Volgograd Polytechnical Institute

[Abstract] Residual stresses were studied in bimetallic and multilayered compounds consisting of titanium alloy plus stainless steel, aluminum alloy plus stainless steel, magnesium alloy, steel plus stainless steel, titanium alloy plus a composite interlayer plus stainless steel. The joints were then subjected to layer separation testing. The titanium-composite-steel joint was welded using a technology which caused the specimens to separate primarily through the steel, due to contact hardening of the layers of copper and niobium in the composite. The other specimens failed through the weakest of the metals used. Thermoplastic deformation was found to play a decisive role in the formation of residual stresses in all cases. Residual stresses exceeded the yield point in the stainless steel in the tempered state near the seams but were significantly less than the yield point in the light alloys used. Tempering redistributed the residual stresses in accordance with the different linear expansion coefficients of the metal welded. Figures 6; references 8: all Russian.
[94-6508]

UDC: 621.791.01:669

BEHAVIOR OF HYDROGEN IN PORES OF SEAMS DURING WELDING OF TITANIUM AND ITS ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 81 pp 32-36
manuscript received 18 Feb 80, in final version 18 Aug 80

REDCHITS, V. V., candidate of technical sciences, and NIKIFOROV, G. D., doctor of technical sciences (Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy)

[Abstract] Most researchers believe that the concentration of hydrogen around pores increases as a result of diffusion of dissolved hydrogen into the stressed metal adjacent to the pore surface. However, considering that the main reason for development of pores during welding of active metals (such as titanium and vanadium) is the presence of hydrogen and that the active metals are occluders for hydrogen, with solubility inversely proportional to temperature, the increase in concentration of hydrogen in the metal layer around a pore may be a result of dissolution of hydrogen contained within the volume of the pore. The hydrogen which forms gas bubbles and pores in the welded seams of active metals is primarily liberated as a result of reactions between water and the metal on the end

surfaces of the edges being welded during heating. A comparison between calculated values of the quantity of hydrogen which might diffuse into a pore under welding conditions with the actual content in the pore can be used to estimate the effectiveness of the process of absorption of hydrogen by the surface layer of titanium. Such calculations were performed for a temperature of 700°C. Results of measurement of the microhardness of metal surrounding such pores in welded specimens following vacuum annealing indicates equalization of the concentration of the gas in the layer adjacent to the pore. It is concluded that one factor in the increased concentration of hydrogen in the layer of metal adjacent to a pore is absorption of hydrogen contained in the volume of the pore. The equalization of concentration of the gas during heating of the welded joint to a temperature above the stability temperature of hydrides is an effective means of reducing the unfavorable influence of the gas saturated layer around the pores on the durability of welded joints in active metals. Figures 2; references 8: all Russian.
[102-6508]

UDC: 621.791.754'293:669.295

INFLUENCE OF TUNGSTEN INCLUSIONS ON QUALITY OF WELDED JOINTS IN VT1-0 TITANIUM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, Mar 81 pp 20-21

LEVCHENKO, V. A., BORISENKO, V. A., ROMANIV, V. I. and KUZYUKOVA, A. N., engineers

[Abstract] A study was made of the influence of tungsten inclusions on the structural state of the fused metal and mechanical properties of welded joints in VT1-0 titanium. The mechanical properties of specimens with and without tungsten inclusions were compared using the same welding conditions. Manual and automatic argon-arc welding were used. Results of the work showed the possibility of entry of tungsten into the metal of the seam during welding at high currents (breakdown of gas shield) and also by contact of the tungsten electrode with the product. However, the dependence of appearance of tungsten inclusions on either of these factors was not clearly established. Difficulties were encountered in intensely producing welded seams with tungsten inclusions; therefore, artificial inclusions were produced by intentionally freezing the tungsten electrode against the product. The tungsten inclusions, up to 2 mm in diameter, formed a transitional zone of higher hardness consisting of solid solutions of titanium in tungsten and tungsten in titanium. Tugnsten inclusions in titanium sheets 6 mm or greater in thickness in the middle of the seam had no practical influence on the quality of the joint. Tungsten inclusions on the surface of the metal greatly decreased the mechanical properties of the welded joints; these inclusions must be removed. Figures 5; references 2: both Russian.
[79-6508]

WHY CUSTOM EQUIPMENT IS NOT BEING USED

Moscow TRUD in Russian 17 Apr 81 p 2

[Article: "High Cost of Miscalculations: Question Put to USSR Minister of Ferrous Metallurgy Ivan Pavlovich Kazanets: Why Does Custom-Built Equipment Stand Around Idle for Years?"]

[Text] A disturbing situation has developed at the construction sites of a number of important ferrous metallurgical industry installations. Hundreds of units of custom-built equipment: rolling mills, machines and highly complex instruments stand idle at construction sites for years, simply rusting away. This includes considerable imported equipment, purchased from foreign countries for hard currency. As of 1 January 1981 total uninstalled equipment at enterprises of the USSR Ministry of Ferrous Metallurgy was estimated at 1 billion 360 million rubles. An above-normal figure by 650 million rubles (one third!) -- this is the value of the machinery and equipment which should have been installed by now, the warranties on which have run out, and in some cases including equipment which was delivered to construction sites and enterprises ahead of schedule or by mistake. One third -- this has now become characteristic of the economy of this branch of industry.

Why has this situation developed? The main reasons are failure to meet construction timetables on new facilities as well as miscalculations in planning, a complacent attitude and a superficial approach to this important problem by high officials at USSR Minchermet [Ministry of Ferrous Metallurgy]. In many cases it is clear from the very outset that construction crews are behind schedule and that construction of a facility will drag on for years, but the ministry nevertheless confirms its orders for imported or Soviet-made equipment. Here is a concrete example. A thin-sheet shop at the Karaganda Metallurgical Combine was scheduled for completion in 1974. The Kazmetallurgstroy Trust of Kazakh SSR Mintyazhstroy [Ministry of Construction of Heavy Industry Enterprises] was regularly failing to meet construction deadlines. And it could not help but do so, for its production base is extremely weak for accomplishing the assigned task. Today as well, seven years later, things are moving poorly: shop technical completion is at 37 percent. But for 10 years now they have been hauling in equipment, 102.7 million rubles worth to date, including 39 million 826 thousand rubles worth of imported equipment.

We shall cite a fact which vividly characterizes miscalculations in planning. A total of 13.6 million rubles worth of Czechoslovak equipment was initially hauled to the Zaporozhstal' Plant. Subsequently they changed their minds about building the shop there and transported the equipment to... Kazakhstan.

Up to 1976 all this equipment stood outdoors, exposed to the elements. When they began to realize that the construction project at Temirtau would be dragging on for years, they finally got the idea of erecting storage structures, to which they moved some of this expensive equipment. But time had done its work. Without having worked a single day, without having turned out a single gram of production, the equipment was aging, rusting away, and parts pilfered. In addition, it had been purchased with a USSR Stroybank loan, which had to be repaid. From the beginning of construction of the thin-sheet shop, a total of 9,391,000 rubles had been withheld from the profits of the Karaganda Metallurgical Combine for failure to install equipment on schedule. The enterprise work force must pay for the sins of others. A total of 1,067,000 rubles has already been spent on equipment repair and renovation. A portion of the electrical equipment which has become useless has had to be reordered, at a cost of 3.8 million rubles, from the Czechoslovak Skoda-Export Association. Incidentally, warranties have long since run out, and now it will be necessary to pay for debugging equipment when it is finally started up and for correcting hidden defects.

It is necessary to pay and keep paying.... About 300,000 have already gone into the wages of warehousemen, freight handlers, crane operators, on depreciation allowances, and on electricity. Enterprise profits have been reduced, meaning a smaller material incentive fund and other funds. The end-of-year bonus has declined (by 10 rubles per worker), and there has been less construction of housing, kindergartens, and recreation facilities....

Temirtau is no exception. Many other enterprises are in a similar situation. And just as is the case at the Karaganda Combine, imported equipment frequently comes from other plants, where it has been standing around idle and useless. Nothing other than poor planning, poor management and irresponsibility can explain the fact that the ministry frequently orders and delivers costly equipment to enterprises which have no need for it at all. Last year alone there were recorded 12 cases of reshipping imported equipment worth 4.6 million rubles from one enterprise to another for this reason.

Frequently officials at USSR Minchermet claim that new facilities are not brought onstream on schedule through the fault of the construction people. They indeed have a point. The metallurgical industry is being let down to a serious extent by contractor organizations of USSR Mintyazhstroy, Minpromstroy [Ministry of Industrial Construction], and Glavmospromstroy. Nevertheless considerable losses could have been avoided with correct, precise planning of equipment deliveries by Minchermet. Can one blame the construction people, for example, for the paradoxical situation whereby USSR Minchermet purchases equipment for facilities which do not even appear on title lists? And this does not involve one or two pieces of machinery but equipment worth 23.1 million rubles, and this figure is for equipment purchased in the last year alone. In October 1979, for example, a flame scarfing machine costing 11.2 million rubles was delivered to the Novolipetsk Metallurgical Plant. It is scheduled to be installed in June 1980. But the construction work requisite for its installation was not specified in the 1980 title list. What is more, the ministry is not even scheduling construction this year.

Sometimes it happens that plans have not even been drawn up yet, and equipment has already been purchased. Last year 7.7 million rubles worth of equipment was purchased under these conditions. For example, 4.9 million rubles worth of imported

equipment for a hot sizing shop at the Magnitogorsk Metal Products Plant was imported last year. And yet Leningrad Gipromez of USSR Minchermet has not yet provided the plant with the requisite documentation. Naturally construction of this facility is not included in the 1981 plan.

There are considerable quantities of uninstalled Soviet and imported equipment with lapsed warranties at the Krivorozhstal' Plant, the Cherepovets, Western Siberian, and Novolipetsk Metallurgical plants, at the Orel Steel Rolling Plant, at the Orsk-Khalilovo Metallurgical Combine, and at other enterprises of this branch.

An economical economy presupposes rigorous, scientifically substantiated planning. Above-standard quantities of equipment, on the scale to which it has piled up and is continuing to pile up in this branch, is an intolerable situation. How does the ministry intend to correct this situation? This question is today a matter of concern to many work forces.

3024
CSO: 1842/91

FUTURE APPLICATIONS OF AMORPHOUS METALS

Moscow TEKHNIKA I NAUKA in Russian No 4, Apr 81 pp 7-8

[Article by L. Klinger and A. Petelin, candidates of physical-mathematical sciences: "Metallic Glass"]

[Text] We learned in school that the solid state of aggregation can be represented by two basic classes of substances -- crystalline, and amorphous. The former possess an ordered atomic structure and above a certain specific temperature pass into a liquid state -- melt. These include practically all natural minerals, many synthetic minerals and, of course, metals. The latter are closer to liquids in structure; upon heating they pass into a liquid state gradually. The atoms in these substances do not occupy definite positions in space. Glass is a typical example of amorphous substances.

Quite recently scientists discovered that if a molten metal is cooled to room temperature very rapidly, its atoms are unable to take the positions corresponding to the points of a crystal lattice. The metal does not crystallize but solidifies like amorphous glass.

How did it happen that two typical representatives formed what would seem to be an incompatible combination -- "metallic glass"? And what cooling rates are required to obtain amorphous metal? There is a specific rate for each metal and alloy, and it ranges from one million to several million degrees per second. With modern equipment this can be accomplished by several methods.

One such method consists in cooling a drop of molten metal on a massive copper drum rotating at a speed of 5-10 thousand rpm. The molten drop, striking the wall of the drum, is flattened by centrifugal force and is elongated into a strip several hundredths of a millimeter in thickness and up to several meters in length. The surface area of the metal increases many times over, and the rate of heat removal from the melt into the metal of the drum increases correspondingly. Thus conditions are created for the practically instantaneous formation of an amorphous, glasslike foil from the molten drop of metal, a finished product ready for commercial application. Equipment of this type is presently in use both in this country and abroad for producing a metallic-glass strip up to 1 meter in width.

The problem of ultrahigh-speed cooling was solved somewhat differently at the Institute of Metallurgy imeni A. A. Baykov of the USSR Academy of Sciences. Drops of

molten metal are fed into a gap between two rapidly spinning rolls. The drops cool instantaneously, transferring heat to the rolls, and are rolled into a foil strip.

Another method is based on the principle of condensation of metal vapor in a vacuum. The process consists in the following. Metal is heated in a high-vacuum chamber. It evaporates and subsequently condenses on a metal substrate. If the thickness of the condensate film does not exceed several tens of angstroms, the metal cools off so rapidly that it solidifies in an amorphous state.

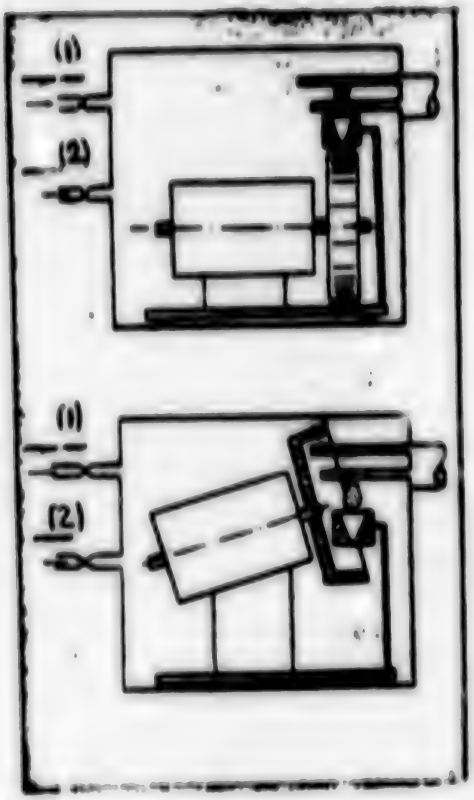
Metallic glass can also be obtained with a powerful laser beam. When metal is irradiated with such a beam, its surface layer evaporates, and then solidifies as soon as the irradiation is terminated. Ultra-rapid cooling with this technique is achieved by drawing off heat from the thin zone subjected to laser action into the bulk of the unheated metal.

The apparent simplicity of obtaining amorphous metal with all these techniques is deceptive. Research has shown that it is essential to observe extremely rigid process occurrence conditions. Small deviations in either direction for any of the parameters (speed of drum rotation, drum mass, degree of evacuation of air from the chamber, substrate material, power of laser pulse, etc) lead to crystallization of the metal. And the following question naturally arises: if it is so difficult to obtain amorphous metal, is it worthwhile to address this problem seriously? For ordinary crystalline metals and alloys have shown they can do a good job. The technology of melting metals is known in great detail, and the most diversified properties can be obtained. The reply to the above question is unequivocally that it is worthwhile. We are correct in stating that amorphous metals will be extensively employed in commercial applications in the very near future. Their unique properties are a guarantee of this.

We shall begin by stating that the tensile strength of amorphous metals approaches the maximum theoretically possible strength of metallic materials in general and is approximately 350 kg/mm^2. We shall note that the strongest of the existing alloys with crystalline structure -- martensitic aging steels -- possess a strength in the order of 250 kg/mm^2. The hardness of amorphous metals also increases correspondingly with their strength. They also possess high resistance to wear -- also an important characteristic.

With such an aggregate of mechanical properties, it is appropriate to speak of the creation of a new class of materials. For example, a composite alloy reinforced with amorphous metal should have a strength of up to 300 kg/mm^2 and possess good plastic properties. Initial steps are already being taken abroad to develop razor blades and drill bits employing amorphous metals. Engineers are discussing the possibility of developing an amorphous-metal strand for metallic cord in heavily-loaded components.

Amorphous alloys possess better corrosion resistance than crystalline alloys of the same composition, for they contain neither grain nor intergrain boundaries along which corrosion penetrates into metal. A comparison of the corrosion resistance of crystalline and amorphous iron indicated that the rate of corrosion of the latter is almost 10 times slower. The following simple experience can serve as an illustration: a metal part, a portion of the surface of which was subjected to laser beam irradiation, with formation of an amorphous layer, was immersed in aqua regia for several seconds. The surface of the part not treated by laser



Experimental Units Developed at the Institute of Metallurgy imeni A. A. Baykov for Producing Metallic-Glass Foil

Key:
1. Helium inlet
2. Evacuation

instantly blackened and became covered with a flaky layer of oxide, while the amorphous metal remained just as bright as prior to immersion in the acid. Thus, if a component is subjected to the effect of laser pulse irradiation, the amorphous layer which forms on the surface will protect it against premature corrosion, surface hardening of the part will occur, and its service life will be extended when operating under friction conditions.

The electrical and magnetic properties of amorphous metals open up extensive prospects for their application in the electrical equipment industry, electronics industry, and in instrument engineering. Since the electrical resistance of metallic glasses is greater than that of ordinary metals, and is more temperature-dependent, amorphous elements can be utilized in the manufacture of resistors and thermistors. Energy losses in transformers can be substantially reduced if transformer cores are made of amorphous alloys, the magnetic characteristics of which are close to those of high-permeability materials. High magnetic permeability in combination with abrasion resistance makes it possible to manufacture amorphous magnetic heads for sound and video recording.

The above represent only a small percentage of the vast area of potential applications of amorphous metals and alloys. The range is quite broad -- from household appliances to highly complex scientific instruments.

In order to be able to utilize these substances commercially with reliability, however, it is necessary to establish the commercial production of metallic glasses, guaranteeing stability of qualities. Scientists at the Institute of Metallurgy imeni A. A. Baykov of the USSR Academy of Sciences, the Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin, the Institute of Steel and Alloys, and a number of other Soviet institutes and research centers are working on these and other problems connected with the properties of amorphous metals.

3024
CSO: 1842/104

UDC: 537.312.62

CRYSTALLIZATION OF CERTAIN SUPERCONDUCTING COMPOUNDS UNDER SPACE CONDITIONS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 1, Mar-Apr 81
pp 102-104 manuscript received 13 Jun 80

SAVITSKIY, Ye. M., corresponding member, USSR Academy of Sciences,
BYCHKOVA, M. I., GILLER, I. D. and PETRENKO, V. G., Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] Three types of specimens were melted and crystallized under weightless conditions: an alloy of tin plus 40% lead; a solid-liquid pair consisting of molybdenum and gallium; and the solid-liquid pair niobium plus tin. A specially designed furnace was used to melt the specimens, which were compared with identical specimens melted under identical conditions on earth. Photomicrographs of the structure of the alloys are presented. Significant differences were found in the processes of diffusion under space and terrestrial conditions. It was found that weightlessness cannot change the temperature at which an alloy becomes superconducting. However, since weightlessness influences the phase composition and may result in the appearance of different phases, further studies of the influence of weightlessness on critical temperature are promising. Critical current, being still more sensitive to structural changes such as variations in crystal dimensions and defects, is a still more promising area for study.
Figures 1; references 4: 3 Russian, 1 Western.
[87-6508]

UDC: 539.52

SUPERPLASTICITY OF ALLOYS WITH SHAPE MEMORY

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 81
pp 158-159 manuscript received 25 Mar 80

TIKHONOV, A. S., SHKVARUNETS, T. I., PROKHOROVA, I. I. and VERKHOVODKINA, Ye. E., Moscow

[Abstract] To determine the deformation conditions resulting in superplasticity of an NiTi alloy (50 at.% Ti), an instron machine was used to perform a series of

tensile tests over a broad range of temperatures (65-95°C) and deformation rates ($1.66 \cdot 10^{-4}$ to $2.08 \cdot 10^{-3}$ sec^{-1}). At 85°C and $\varepsilon = 7 \cdot 10^{-3}$ sec^{-1}, the alloy tested manifests superplasticity. The results are of great practical significance, with the flow stress decreasing and plasticity increasing in the thermoelastic martensitic conversion range at 85°C. The critical degree of deformation can be significantly increased without losing the effect of shape memory. Figures 2; references 5: all Russian.
[97-6508]

UDC 669.74:548.76/73.295

INVESTIGATING DEFORMATION OF MONOCRYSTALS OF ALLOYS BASED ON MANGANESE AND THE EFFECT OF MEMORY SHAPE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 51, No 4, Apr 81 pp 841-849 manuscript received 24 Jan 80

VINTAYKIN, Ye. Z., MAKUSHEV, S. Yu., LITVIN, D. F. and GEORGIYEVA, I. Ya., Institute of Physical Metallurgy and Physics of Metals and Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] The deformation of single crystals of tetragonal γ-manganese alloys was investigated experimentally over a wide range of orientations of the strain axes and the interaction of twinning and slip mechanisms at different stages of deformation was studied as a factor of formation of reversible shape memory. The compression curves of single crystals of manganese and manganese-iron-copper alloys having twinned face-centered tetragonal structure were found. The anti-ferromagnetic texture during deformation and the behavior of the deformed specimens during cyclic heating and cooling were investigated by neutron diffraction analysis and dilatometry. Deformation occurs primarily in displacement of domain walls with mild deformation. The displacement of domain walls is accompanied by accomodation slip in the region of increased stresses. The shape variation of single crystals deformed in the region of increased stresses and beyond the yield point by ordinary slip is almost completely reversible. Figures 6; references 15: 9 Russian, 6 Western.
[107-6521]

UDC 620.178.311:669.295'24

STRENGTHENING AND EFFECT OF SHAPE MEMORY IN NICKEL-TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 5, May 81 pp 57-59

YERMAKOV, V. M., KOLOMYTSEV, V. I., LOBODYUK, V. A. and KHANDROS, L. G., Institute of Physical Metallurgy, Ukrainian SSR Academy of Sciences, and All-Union Scientific Research Institute of Aviation Materials

[Abstract] The effect of high-temperature aging on the structure, hardness and effect of shape memory of some hardened nickel-titanium binary alloys was investigated. The alloys were melted from titanium and nickel by arc melting in an argon medium. The main changes of microhardness and buckling occur after aging at 300-600°C. An x-phase with face-centered cubic lattice forms in the temperature range of 300-700°C, which causes a change in microhardness and buckling upon heating of the alloys. Heat treatment at 1,000°C in water for 15-20 minutes and annealing at 450°C for 30-60 minutes produce the greatest hardening and lowest buckling in nickel-titanium alloys. Figures 3; references 7: 3 Russian, 4 Western.
[105-6521]

UDC: 669.3'71'74:548.76/73.295

REVERSIBLE SHAPE CHANGE IN A COPPER-ALUMINUM-MANGANESE ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 51, No 2, Feb 81 pp 431-434 manuscript received 6 Jun 79, in final form 19 Dec 79

DOBROVOL'SKAYA, T. L., TITOV, P. V. and KHANDROS, L. G., Institute of Metal Physics, Ukrainian Academy of Sciences

[ABstract] A study is made of reversible shape change caused by loading of a Cu-Al-Mn alloy, leading to the appearance of deformation martensite, with tempering in the elastically deformed state. The composition of the alloys was: Al 13.5-14.3 Wt.%, Mn-2-3.5 Wt.%, Cu - remainder. Hardened specimens consisting of rectangular rods 40 mm in length and 0.8 x 3 mm in cross section were ground from 0.8 mm to 0.1-0.3 mm on one side at 20°C or tempered at 200-300°C in the elastically bent state. The studies showed that after plastic deformation of the β_1 phase a reversible shape change occurs. The decrease in the reversible shape change upon subsequent heating is accompanied by a decrease in residual deformation, and results from relaxation of residual stresses as well as hardening of the matrix and liberation of new phases upon partial decomposition of the β_1 solid solution. Figures 3; references 6: 5 Russian, 1 Western.
[92-6508]

UDC 622.765:546.791:546.841

SEPARATION OF URANIUM^{VI} AND THORIUM^{IV} IN SULFATE SOLUTIONS BY IONIC FLOTATION

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 2, Mar-Apr 81 pp 66-68 manuscript received 4 Apr 80

SKRYLEV, L. D., MENCHUK, V. V., SAZONOVA, V. F. and MINAYEV, I. M., Odessa State University, Chair of Physical Chemistry

[Abstract] Ionic flotation from sulfate solutions has been proposed as a very efficient and inexpensive method of separating uranium and thorium. Here the results of tests are presented, binary sulfate solutions with up to 50 mg/liter U and Th having been used with secondary and primary aliphatic amines serving as collectors of the respective elements. The efficiency of separation, no uranium flotable by primary amines and no thorium flotable by secondary amines, was found to depend on the concentration of hydrogen ions. Thus only uranium is flotable at a pH = 0.5-3.0, while at a pH > 3.0 also thorium becomes flotable. It is therefore possible, by proper selection of the collector substance and matching of the pH, to regulate the extraction of uranium and thorium selectively: one without the other or one after the other. Figures 2; references 8: all Russian.
[123-2415]

UDC 546.28'21

STUDY OF TITANIUM ADSORPTION AT A (111) SILICON FACE BY METHOD OF SECONDARY-ELECTRON SPECTROSCOPY

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 17, No 5, May 81 pp 765-768 manuscript received 4 Apr 80

BUZANEVA, Ye. V. and GORCHINSKIY, A. D., Kiev State University imeni T. G. Shevchenko

[Abstract] While titanium films can be formed on silicon substrates, titanium is also one of the metals forming chemical compounds with silicon. Here the effect of titanium adsorption on the electron states of the silicon substrate at room temperature was studied by three techniques: Auger electron spectroscopy, diffraction of slow electrons, and spectroscopy of characteristic energy losses. The test specimens were produced with a molecular titanium beam on a (111) face of a chemically pure silicon single crystal ($\rho = 5 \cdot 10^{-3}$ ohm·m). The spectra as well as the transient buildup of titanium Auger peaks and decay of silicon Auger peaks indicate a layerwise formation of a continuous titanium coating. Before the coating has become half a monolayer thick, the energy of the silicon surface plasmon increases. As the coating becomes thicker than half a monolayer, a titanium surface plasmon forms fast and metallization of the film at the silicon surface begins. Figures 4; references 11: 2 Russian, 9 Western.
[122-2415]

UDC: 539.432+620.178.3+620.194.8+621.438+621.515

INFLUENCE OF A SEA SALT SOLUTION ON GROWTH RATE OF FATIGUE CRACKS IN STAINLESS STEEL AND VT3-1 ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 81 pp 69-73
manuscript received 29 Apr 80

TROSHCHENKO, V. T., PROKOPENKO, A. V. and TORGOV, V. N., Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] A study is made of the influence of a solution of sea salt on the rate of growth of fatigue cracks in martensitic stainless steels types 20Kh13, Kh17N2, 1Kh12N2VMF, A and VT3-1 alloy. The specimens were tested in cantilever bending at resonant frequency on a vibration test stand with an electromagnetic exciter, with a solution of salt from the Black Sea sprayed on the specimens. For all of the materials studied the stress intensity factor was significantly lower in a salt spray than in air. The crack growth rate of VT3-1 was approximately an order of magnitude higher both in air and in the salt spray than that of the stainless martensitic steels. Types 20Kh13 and A showed the best characteristics of cyclical crack resistance in the salt solution. Figures 2; references 5: 4 Russian, 1 Western.
[95-6508]

UDC: 669.25'71:620.181

FORMATION OF NEW MULTILAYER MARTENSITIC PHASES IN Co-Al ALLOYS--APPEARANCE OF POLYTYPISM IN METAL ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 51, No 2, Feb 81 pp 316-325 manuscript received 29 Jul 79, in final form 13 Nov 79

NIKOLIN, B. I. and SHEVCHENKO, N. N., Institute of Metal Physics, Ukrainian Academy of Sciences

[Abstract] X-ray studies were performed of the crystalline structure of martensitic phases arising in a Co-Al single crystal with a concentration of 2.0 to 8.0 Wt.% Al upon nondiffusion transformation after hardening from 1100-1300°C, aging at 400-800°C and repeated transition between β and α phases. The procedures used for each of the steps are described in detail. The studies showed that four multilayer martensitic phases with long-period lattices are formed in Co-Al single crystals after hardening and also after preliminary aging. The concentration area of appearance of the multilayer structures on the concentration-temperature phase diagram is determined. The analogy between polytypic and martensitic crystalline lattices indicates that the long-period martensitic phases in Co-Al, Co-Cu and Co-Ti alloys can be considered polytypic structures in metal alloys, since they have the primary structural characteristics of polytypism, previously known only in inorganic crystals such as SiC, never in pure metals or metal alloys. Figures 5; references 15: 13 Russian, 2 Western.
[92-6508]

UDC: 539.23:669.7815'786

PROPERTIES OF BORON NITRIDE FILMS OBTAINED BY DECOMPOSITION OF BORAZINE IN AN HF PLASMA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 81 pp 85-88 manuscript received 24 Aug 78

SAVEL'YEV, A. A., PUKHOV, A. A., VISHNYAKOV, B. A., SULIMIN, A. D. and ISHCHENKO, A. P., Moscow

[Abstract] High purity stoichiometric powders and films of BN can be produced by a plasmochemical method of precipitation using individual BN compounds in which the boron and nitrogen are present in an atomic ratio of 1:1. The compounds must be highly pure, highly volatile and must not liberate corrosive gases during synthesis of BN. Borazine ($B_3N_3H_6$), a cyclical inorganic compound with a benzene-like ring, satisfies these requirements. BN films were produced in an HF-electrode coaxial reactor, with the film thickness building up linearly with time and increasing percent content of borazine. The purity of the nitrogen added to the chamber during the process had a great influence on the quality and composition of the BN films produced. Adhesion of the BN films depended on the application conditions, type of substrate and was always higher on silicon plates than on aluminum plates. The index of refraction of the BN films varied from 1.65 to 2.1. Deposition rates were 3 to 4 micrometers per hour. The electrophysical parameters of the films produced were quite stable. Figures 2; references 9: 7 Russian, 2 Western.
[97-6508]

UDC: 669.187.25:669.984

STUDY OF REFINING PROCESSES OF NICKEL-BASED ALLOYS IN VACUUM PLASMA-ARC REMELTING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 81 pp 46-50 manuscript received 30 Dec 78

NIKOLAYEV, A. V., SHEREMET'EV, V. A., TUZHIKOV, V. F., YUNAKOV, V. N., OKOROKOV, G. N., GAGANOV, Yu. I., ERZHANOVA, Ye. N. and BORTNICHUK, N. I., Moscow

[Abstract] A study is made of the possibilities of vacuum plasma arc remelting, particularly in refining of nickel-based alloys and complex alloys of steel to remove gases and nonferrous metal impurities. High temperature alloys such as nichrome, EI-437 Bu, EI-617 and type 18-8 stainless steel were studied, melted in vacuum plasma-arc furnaces with primary attention given to determination of the rate of melting and application of power, as well as the pressure in the furnace. The variation of total metal loss to evaporation as a function of melting rate, arc power and furnace chamber pressure was studied. The total losses to evaporation did not exceed 1 to 3%, as opposed to 5-7% for electron-beam remelting. Decreasing the pressure in the chamber from 10^{-1} to 10^{-3} mm Hg

reduced the content of chromium. After remelting, the greatest changes were found to have occurred in the content of elements with high vapor tension (chromium and manganese). The content of silicon, sulphur and phosphorus remained practically unchanged upon remelting. There was some decrease in the content of carbon, apparently liberated as CO. Increasing the vacuum allowed the alloying elements with high vapor tension to be retained within the limits corresponding to the requirements of the technical conditions. Success in removal of unwanted nonferrous impurities will vary with their vapor tension under the remelting conditions used. Figures 3; references 5: all Russian.
[97-6508]

UDC: 621.791

SLIGHT PERTURBATION OF A CONCENTRATED FLOW OF ENERGY TO SURFACE OF A METAL

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 81 pp 16-20 manuscript received 4 Jul 80

UGLOV, A. A. and GUS'KOV, A. P., Moscow

[Abstract] The influence of the initial temperature profile on changes in the surface temperature and resultant recoil pulse during evaporation of the surface of a metal specimen under the influence of a concentrated flux of energy remains unclear. This article studies this problem, representing the reaction of the temperature of the surface of the metal to the transition from one mode of evaporation, determined by the initial temperature profile, to another steady mode. From the practical standpoint this problem is of interest because this is the model usually used in numerical estimates of temperature conditions and because the resonant reaction to an external disturbance must influence the behavior of the bath of melt in the irradiated area, and also because the pulse response to a change in energy flux can be used to judge the adequacy of the model of the physical process. When a concentrated energy flux acts upon the surface of a metal specimen the change in surface temperature and recoil pulse in the melt bath depend essentially on the initial temperature profile. Figures 2; references 6: 5 Russian, 1 Western.
[97-6508]

UDC: 620.226.29

KINETICS OF CREEP PROCESS OF NIOBIUM ALLOYS IN A SUPERHIGH VACUUM

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 81 pp 55-58
manuscript received 4 Jul 80

TSVILYUK, I. S., Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] A study is presented of the kinetics of the process of creep of niobium alloys over a broad range of temperatures and stresses. The alloys studied contain W, Mo and Ta as well as Ti and Zr simultaneously. The creep tests were conducted in a superhigh vacuum in which practically no saturation of the specimens with interstitial impurities occurred using standard specimens prepared from 1 mm sheet. The studies of the kinetics of accumulation of creep deformation in the third stage for niobium alloys indicate that this stage can be divided into two substages, accelerated creep plus an area in which the accumulation of deformation is proportional to $\exp(\beta\tau)$ and involves intensive failure of the material. The kinetics of accumulation of plastic deformation of niobium alloys is similar to that of heat resistant metal materials. Figures 5; references 7: all Russian.
[101-6508]

UDC: 539.388.1

INFLUENCE OF CYCLIC AND STATIC STRESSES ON CYCLIC CREEP PROCESS OF HEAT-RESISTANT NICKEL ALLOYS WITH MULTICYCLE LOADING

Kiev PROBLEMY PROCHNOSTI in Russian No 3, Mar 81 pp 50-55
manuscript received 12 Oct 79

GOLUB, V. P., Institute of Mechanics, Ukrainian Academy of Sciences, Kiev

[Abstract] A study is made of the influence of static and cyclic stresses on the rate and deformation of high temperature cyclic creep during multicycle loading. The objects studied were heat-resistant nickel-based alloys EI867, EP109, and VZhL12U and Zh86U after typical heat treatment, used in the manufacture of gas turbine vanes and wheels. Creep curves constructed from the results of testing of at least three specimens reflect the general trend of the influence of unbalanced stress cycles on the process of cyclical creep of the alloys tested. The process of creep is found to intensify considerably under the experimental conditions. Both the static and the cyclic components of the unbalanced stress cycle cause a significant increase in creep rate and deformation as they increase. Mathematical processing of the experimental data produced indicates that the variation in the stable rate of cyclic creep as a function of the static and cyclical components can be satisfactorily approximated by exponential functions. The principle of superposition of the effects of static and cyclic stresses can be used to calculate the rate of cyclic creep. Figures 4; references 12: 11 Russian, 1 Western.
[101-6508]

UDC: 669.017.3:536.421.4

DIRECTED CRYSTALLIZATION OF EUTECTIC ALLOYS WITH FORMATION OF A LAMELLAR STRUCTURE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 4, 1981 pp 867-871
manuscript received 17 Dec 80

PETUKHOV, Yu. I., Institute of Thermal Physics, Siberian Division,
USSR Academy of Sciences, Novosibirsk

[Abstract] A model of the formation of a lamellar structure in the process of natural formation of composites upon crystallization of eutectic alloys is studied. The model describes the process without using any additional conditions which do not follow from the physical essence of the problem, and allows computer calculation of all geometric and physical parameters of the phenomena. It is demonstrated that the problem of formation of eutectic plates upon crystallization can be solved without utilization of heuristic conditions at the phase boundary. The form of the boundary under steady growth conditions must be locally matched with the supercooling field which in turn depends on the form of the boundary. If a curve can be found which satisfies this requirement of matching of field and form the problem is solved. An algorithm for construction of such curves is described. Figures 2; references 10: 3 Russian, 7 Western.
[93-6508]

UDC: 539.217.1+539.214

SOLUTION-PRECIPITATION MECHANISM AS A FACTOR IN DEVELOPMENT OF GRAIN-BOUNDARY DISCONTINUITY IN SUPERPLASTIC ALLOYS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 4, 1981 pp 863-866
manuscript received 29 Nov 80

KUZNETSOVA, R. I. and KAYBYSHEV, O. A., Khar'kov State University;
Ufa Aviation Institute imeni Ordzhonikidze

[Abstract] The question of initiation of grain-boundary pores in superplastic materials remains open. A study was performed using a typical superplastic alloy consisting of Zn+22 mass % Al, heated from room temperature to the temperature of the eutectoid T_2 transformation without passage through the eutectoid level. Data on changes in lattice periods with changes in concentration of the components in the α and β phases were used to calculate the density of the phases T_1 and T_2. The calculations showed that heating and homogenization of the eutectoid alloy at a temperature near 275°C results in a decrease in the zinc-rich α phase by 6.52%, and an increase in the aluminum-rich β phase by 6.45%. Significant internal tensile stresses develop at the interphase boundaries which, with the addition of slight external stresses, may lead to breakage of bonds and formation of discontinuities at the boundary. If there is a great difference in the steepness of the temperature variations of solubility limit, layer separation

between α and β phases will always occur upon heating and homogenization due to the dissolution-precipitation mechanism regardless of other factors and a porous structure will be created in the alloy, resulting in superplasticity. This is apparently the reason for easy development of superplasticity in these typical superplastic alloys. References 15: 9 Russian, 6 Western.
[93-6508]

UDC: 536.45

MODEL OF AUTO-OSCILLATIONS UNDER INFLUENCE OF CONTINUOUS CONCENTRATED ENERGY FLUX ON A SUBSTANCE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 1, Mar-Apr 81 pp 99-101
manuscript received 4 Dec 80

RYKALIN, N. N., academician; SKOBELKIN, V. I., ZUYEV, I. V., SELISHCHEV, S. V. and UGLOV, A. A., Moscow Institute of Electronic Technology

[Abstract] The amplitude and frequency of the limiting cycle of self-excited oscillations are calculated for the case when an electron beam strikes the surface of a metal target and the energy is dissipated in the vapor of the target substance which evaporates as it is bombarded. The results produced are applicable not only to an electron beam, but also to a flux of any type of energy. References 5: all Russian.
[87-6508]

UDC 541(64+11) : 546.14

THERMOCHEMICAL STUDY OF CARBON FIBERS BASED ON POLYACRYLONITRILE AND MODIFIED WITH BORON

Moscow VYSOKOMOLEKULYARNYYE SOYEDINENIYA in Russian No 11, Nov 80 pp 2598-2603
manuscript received 30 Nov 79

KOZYKINA, M. A., FAYNBERG, E. Z., PAPKOV, S. P., VARSHAVSKIY, V. Ya., KUMOK, I. L. and KONKIN, A. A., Khimvolokno Scientific Production Association

[Abstract] In carbon materials modified with boron the addition of boron promotes the graphitization process, whereby part of the boron enters the graphite lattice and leads to some disordering of it. A study of this phenomenon is made here for carbon fibers, including a discussion of the distinctive features of the process of the graphitization of an oxidized polyacrylonitrile (PAN) fiber in the presence of boron compounds, and the role of boron in this process is evaluated. In order to verify the hypothesis of the preferred formation of boron nitride in this process, a determination was made of the content of nitrogen and boron in samples of fibers subjected to various heat treatment temperatures including the temperature region for the dissociation of boron nitride. Curves

illustrate the dependence of the content of boron in carbon fibers on the amount of boron added and on the heat treatment temperature, and the dependence of the content of nitrogen in carbon fibers on the heat treatment temperature with an increase in the amount of boron added from 0 to 1.3 percent by weight. The nitrogen content was estimated from analyzing combustion products and adding corrections for the conversion of nitrogen into its oxides. The experimental data demonstrate that nitrogen is contained in all samples modified with boron and differing in terms of heat treatment temperature (up to 2700°C), heat treatment time from 60 to 900 sec and content of boron in the fiber from 0.4 to 4 percent. The boron nitrode formed in the heat treatment process is partly preserved in the finished graphitized fiber. An oxygen-containing boron compound in the process of heat treatment of the fiber undergoes the following changes: the formation of boron nitride, and the dissociation of the boron nitride above a temperature of 2000°C into nitrogen and elemental boron with the latter entering the crystal lattice of the graphite. An analysis was made of values of the combustion enthalpy of samples with a low boron content for the purpose of verifying the hypothesis that the modification of carbon fibers with boron is conducive to intensification of the graphitization process. The combustion enthalpy was calculated for samples with a high boron content by taking into account the formation of two phases: of boron nitride and of solution of boron in the carbon. The combustion enthalpy data arrived at make it possible to conclude that the combustion enthalpy of a modified carbon fiber is lower than that of an unmodified carbon fiber at the same heat treatment temperature. This represents a thermochemical confirmation of the positive influence of modifying additives on the graphitization process. The optimum effect of a modifying additive is observed at a heat treatment temperature of 2400°C. Changes in the combustion enthalpy are determined by the total influence of the change in the degree of graphitization and by disordering of the lattice resulting from the addition of boron to the graphite crystal lattice. It is suggested that the influence of the first factor prevails. It is concluded that the reason for the intensification of the graphitization stage in the presence of boron is the influence of boron nitride, the formation of which in the fiber at the early stages of heat treatment is most preferred. The boron nitride plays the role of a crystallization center which accelerates the graphitization process in a carbon fiber based on PAN. A study of the relationship between the degree of graphitization and the mechanical properties of a fiber demonstrated that with a degree of crystallinity of approximately 80 percent and higher a slight increase in the degree of graphitization results in a drastic increase in the elastic modulus. The hypothesis is advanced that the experimentally observed sudden increase in the elastic modulus of a modified carbon fiber is caused exclusively by the slight increase in the degree of graphitization and not by the specific influence of boron entering the substitution solution. Figures 3; references 14: 13 Russian, 1 Western.
[18-8831]

CSO: 1842 END

END OF FICHE DATE FILMED

22 July 1981